N00204.AR.004551
NAS PENSACOLA
5090.3a

FINAL REMEDIAL ACTION PLAN FOR UNDERGROUND STORAGE TANK SITE 22 REVISION 3 NAS PENSACOLA FL

9/1/2013

TETRA TECH

Comprehensive Long-term Environmental Action Navy

CONTRACT NUMBER N62467-04-D-0055

Rev. 3
September 2013

Final
Remedial Action Plan
for
Underground Storage Tank
Site 22

Naval Air Station Pensacola
Pensacola, Florida

Contract Task Order 0030

SEPTEMBER 2013

NAVFAC
Naval Facilities Engineering Command

Naval Facilities Engineering Command Southeast
P.O. Box 30 – Bldg 903
Jacksonville, Florida 32212

TETRA TECH

REMEDIAL ACTION PLAN
FOR
UNDERGROUND STORAGE TANK
SITE 22
(INSTALLATION RESTORATION SITE 21)

NAVAL AIR STATION PENSACOLA
PENSACOLA, FLORIDA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Naval Facilities Engineering Command Southeast
NAS Jacksonville
Jacksonville, Florida 32212-0030

Submitted by:
Tetra Tech, Inc.
661 Andersen Drive
Foster Plaza 7
Pittsburgh, Pennsylvania 15220

CONTRACT NUMBER N62467-04-D-0055
CONTRACT TASK ORDER 0030

SEPTEMBER 2013

PREPARED UNDER THE SUPERVISION OF:

Gerald Walker

GERALD WALKER, P.G.
TASK ORDER MANAGER
TETRA TECH, INC.
TALLAHASSEE, FLORIDA

APPROVED FOR SUBMITTAL BY:

John Trepanowski for DMH

DEBRA M. HUMBERT
PROGRAM MANAGER
TETRA TECH, INC.
PITTSBURGH, PENNSYLVANIA

Rev. 3
September 2013

This document, the *Remedial Action Plan for Underground Storage Tank (UST) Site 22 (Installation Restoration Site 21), at Naval Air Station Pensacola, Pensacola, Florida*, has been prepared by or under the direction of a Florida Registered Professional Engineer. The work and professional opinions rendered in this report were conducted or developed in accordance with commonly accepted procedures consistent with applicable standards of practice. This document was prepared for UST Site 22 at Naval Air Station Pensacola, Pensacola, Florida and should not be construed to apply to any other site.

Tetra Tech, Inc.
1558 Village Square Blvd., Suite 2
Tallahassee, FL 32309
Certificate of Authorization No. 2429

Michael O. Jaynes 9/12/13

Michael O. Jaynes Date
Professional Engineer
State of Florida License No. 56441
Expires: February 28, 2015

TABLE OF CONTENTS

APPENDICES

TABLES

NUMBER

FIGURES

NUMBER

ACRONYMS and ABBREVIATIONS

AST	Aboveground Storage Tank
ATSDR	Agency for Toxic Substances and Disease Registry
AVGAS	Aviation Gasoline
bls	below land surface
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BTOC	below top of casing
CAD	Computer Aided Design
CAR	Contamination Assessment Report
cfm	cubic feet per minute
CKD	cement kiln dust
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Chemicals of Concern
CTO	Contract Task Order
DE	Direct Exposure Limit
DE1	Direct Exposure-Residential
DE2	Direct Exposure-Industrial
DO	Dissolved Oxygen
DOT	Department of Transportation
DPE	Dual-Phase Extraction
DPT	Direct-Push Technology
DTW	Depth-to-water
EDB	Ethyldibromide
EDC	1,2-dichloroethane
F.A.C.	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FID	Flame Ionization Detector
FL-PRO	Florida Petroleum Range Organics
ft	Feet (Foot)
ft^2	Square Feet
GAC	Granular Activated Carbon
GAG	Gasoline Analytical Group
gals	Gallons
GCTLs	Groundwater Cleanup Target Levels
gpm	gallons per minute
Hg	Mercury

ACRONYMS (Continued)

i	Hydraulic Gradient
IR	Installation Restoration
K	Hydraulic Conductivity
LDA	Large Diameter Auger
LE	Leachability Limit
lbs	Pounds
µg/L	Micrograms per Liter
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
MNA	Monitored Natural Attenuation
MOP	Monitoring Only Plan
MTBE	Methyl Tertiary Butyl Ether
NADC	Natural Attenuation Default Concentration
NAAS	Naval Auxiliary Air Station
NAS	Naval Air Station
NAVFAC SE	Naval Facilities Engineering Command South East
NEESA	Naval Energy and Environmental Support Activity
NETPDTC	Naval Education and Training Professional Development and Technical Center
NETPMSA	Naval Education and Training Program Management Support Activity
NTTC	Naval Technical Training Center
n	Porosity
O&M	Operations and Maintenance
OLF	Outlying Landing Field
OVA	Organic Vapor Analyzer
PAH	Polynuclear aromatic hydrocarbon
ppm	parts per million
PWC	Public Works Center
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
ROI	Radius of Influence
RSS	Rescue Swim School

ACRONYMS (Continued)

SA	Site Assessment
SAR	Site Assessment Report
SARA	Site Assessment Report Addendum
SCTLs	Soil Cleanup Target Levels
SCFM	standard cubic feet per minute
SOP	Standard Operating Procedure
SPLP	Synthetic Precipitation Leaching Procedure
STP	Standard Temperature and Pressure
SVE	Soil Vapor Extraction
SWL	Static water level
TCLP	toxicity characteristic leaching procedure
TRPH	Total Recoverable Petroleum Hydrocarbons
TSDF	Treatment, Storage, and Disposal Facility
toc	top of casing
Tetra Tech	Tetra Tech, Inc. or Tetra Tech NUS, Inc
USGS	United States Geological Survey
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

Tetra Tech, Inc. (Tetra Tech) has been tasked to prepare a Remedial Action Plan (RAP) for the Naval Facilities Engineering Command Southeast (NAVFAC SE) under Contract Task Order (CTO) 0056, for the Comprehensive Long-term Environmental Action Navy (CLEAN) IV, Contract Number N62467-04-D-0055. This RAP was prepared for Underground Storage Tank (UST) Site 22 [Installation Restoration (IR) Site 21] located at Naval Air Station (NAS) Pensacola, in Escambia County, Florida. This document was prepared in general accordance with the requirements of Chapter 62-770, Florida Administrative Code (F.A.C.) and is being submitted to the Florida Department of Environmental Protection (FDEP) for approval.

The purposes/objectives of this RAP are to:

- Review the information provided in the Contamination Assessment Report (CAR) [Navy Public Works Center (PWC), 1997], and the subsequent Site Assessment Report (SAR) Addendums (SARAs), SARA I, SARA II, and SARA III (Tetra Tech, 2001, 2003, and 2011, respectively).
- Prepare a RAP to address soil (above the water table) containing polynuclear aromatic hydrocarbons (PAHs) exceeding the Florida industrial soil cleanup target level (SCTL) at Site 22.
- Provide, as part of the RAP, a conceptual site design for evaluating the effectiveness of current engineering controls (the seawall) for the containment of lead contamination in groundwater, and a monitoring plan for evaluating the ability of Monitored Natural Attenuation (MNA) to address ethylbenzene, xylenes, 1-metyhlnaphthalene, 2-methylnaphthalene, naphthalene, TRPH, lead and manganese in groundwater at Site 22.

Following the implementation of this RAP, if the petroleum-related constituents (aviation gasoline components) that impacted soil and groundwater at the Site do not meet their cleanup goals in a reasonable time frame, a subsequent RAP or RAP Addendum would be prepared. The RAP or RAP Addendum would address the contaminants that remain at concentrations exceeding their cleanup levels in soil and groundwater.

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This Remedial Action Plan (RAP) was prepared by Tetra Tech, Inc. (Tetra Tech) for Naval Facilities Engineering Command Southeast (NAVFAC SE) under Contract Task Order (CTO) 0056, for the Comprehensive Long-term Environmental Action Navy (CLEAN) IV, Contract Number N62467-04-D-0055. This RAP was prepared to address Total Recoverable Petroleum Hydrocarbons (TRPH) and polynuclear aromatic hydrocarbon (PAH) contamination in soil, evaluate and recommend feasible, cost effective, and timely remedial alternatives to address ethylbenzene, xylenes, 1-metyhlnaphthalene, 2-methylnaphthalene, naphthalene, manganese and lead contamination in groundwater at Underground Storage Tank (UST) Site 22 [Installation Restoration (IR) Site 21], hereafter referred to as "UST Site 22" or "Site 22." Site 22 is located at Naval Air Station (NAS) Pensacola, in Escambia County, Florida.

The objectives of this RAP are to address existing soil (above the water table) containing PAHs exceeding Florida industrial direct exposure soil cleanup target levels (SCTLs) at the Site, evaluate the effectiveness of current engineering controls (the seawall) at the Site for the containment of lead contamination in groundwater, and to assess monitored natural attenuation (MNA) as a viable remedial option to address ethylbenzene, xylenes, 1-metyhlnaphthalene, 2-methylnaphthalene, naphthalene, TRPH, manganese and lead in groundwater at UST Site 22. The scope of this RAP provides a conceptual design for the Site and selected alternatives in accordance with the requirements of Chapter 62-770, Florida Administrative Code (F.A.C.).

If petroleum-related constituents (aviation gasoline components) that impacted soil and groundwater at the Site do not meet their cleanup goals in a reasonable time frame following the implementation of this RAP, a RAP Modification or RAP Addendum would be prepared to re-evaluate alternative remedies. The RAP Modification or RAP Addendum would address the contaminants that remain at concentrations exceeding their cleanup levels in soil and groundwater at the Site

1.2 SITE DESCRIPTION

NAS Pensacola (Figure 1-1) is located in Escambia County, in Florida's northwest coastal area, approximately 5 miles west of the Pensacola City limits. The approximately 5,000-acre installation was constructed in the 1800's. Prior to construction, the facility was undeveloped and sparsely vegetated.

Current land use at NAS Pensacola consists of: areas used for flight operations at Forrest Sherman Field; various military housing, training, and support activities; and historical facilities open to the public including Gulf Islands National Seashore and the National Museum of Naval Aviation.

Site 22 (Figure 1-2) is located in the southeastern portion of the facility, immediately north of and adjacent to the NAS Pensacola waterfront on Pensacola Bay. The Site is mostly unpaved, and is bordered to the north by the newly constructed Rescue Swim School (RSS) and Gymnasium. The Site is bordered to the west and east by paved areas consisting of Duncan Road and a parking lot, and to the south by Pensacola Bay. The Seawall adjacent to Pensacola Bay is constructed of a concrete barrier underlain by interlocked vertical steel sheet piling. The total barrier extends from the land surface to approximately 28 to 30 feet below land surface (bls). The total area covered by the Site is approximately 23 acres.

Site 22 and the surrounding area have undergone extensive construction/demolition activities since 2004. Current site conditions are presented on Figure 1-3. The recent increase in activity was brought on by the landfall of Hurricane Ivan and renovation/new construction to meet a pre-existing need for updates to NAS Pensacola. Projects that are ongoing or that have recently been completed at Site 22 include:

- Beach/seawall restoration program that involved the removal of several buildings, the old obstacle course and a tennis court along the damaged seawall area by the Site. The Seawall was repaired and area was subsequently graded with beach sand and planted with native vegetation.
- Construction of the new RSS and gymnasium.
- Construction of a new parking lot and sidewalks.
- Demolition of the barracks adjacent to the northern section of the Site.
- Re-paving of Radford Boulevard.

Many of the monitoring wells in the study area have either been destroyed or covered during the site renovation/new construction activities. Three monitoring wells (MW31, MW46, and MW54) have previously been replaced.

1.3 SITE HISTORY

Naval operations began on Pensacola Bay in 1825, and expanded between 1828 and 1835. However, after several natural disasters in the early 1900s, the Navy Yard was forced into maintenance status for a 3-year period. In 1914, the first U.S. Naval Air Station was established and became the primary training base for naval aviators. NAS Pensacola is known as the “Cradle of Naval Aviation” because it is where every Naval Aviator, Naval Flight Officer, and enlisted air crewman begin flight training. It is also the Navy’s premier location for enlisted aviation technical training [Agency for Toxic Substances and Disease Registry (ATSDR), 2006].

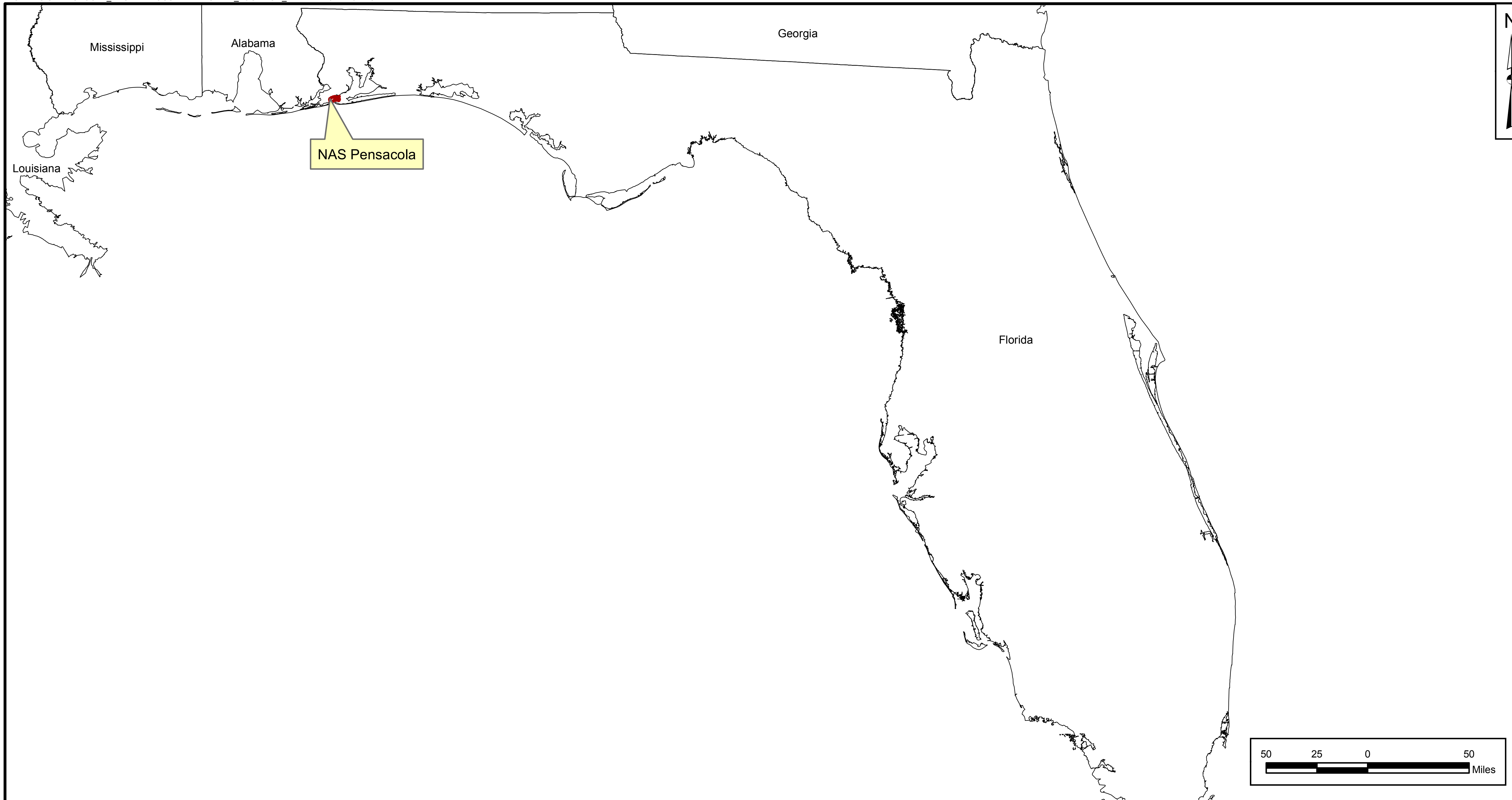
Site 22 is the former location of an Aviation Gasoline (AVGAS) tank farm. From approximately 1940 to the late 1960's, nine above ground storage tanks (ASTs) were used to store aviation gasoline at the Site. The tanks were cleaned annually and the sludge from the bottoms of the tanks was supposed to have been disposed of on the ground surface in the immediate vicinity of the tanks from 1951 to 1967 [Naval Energy and Environmental Support Activity (NEESA), 1983]. The ASTs were removed from the Site at an unknown date. It is unknown if any soils were excavated and disposed of during the tank removal. The majority of the Site is currently covered with grass. Building 670, a former fuel system pump house, was located at the eastern edge of the Site, south of Radford Boulevard. Two USTs used for containment of contaminated fuel were reportedly associated with Building 670.

1.4 REPORT ORGANIZATION

This RAP is organized into eight sections. Below is a list of the sections and a brief description of their contents/purpose:

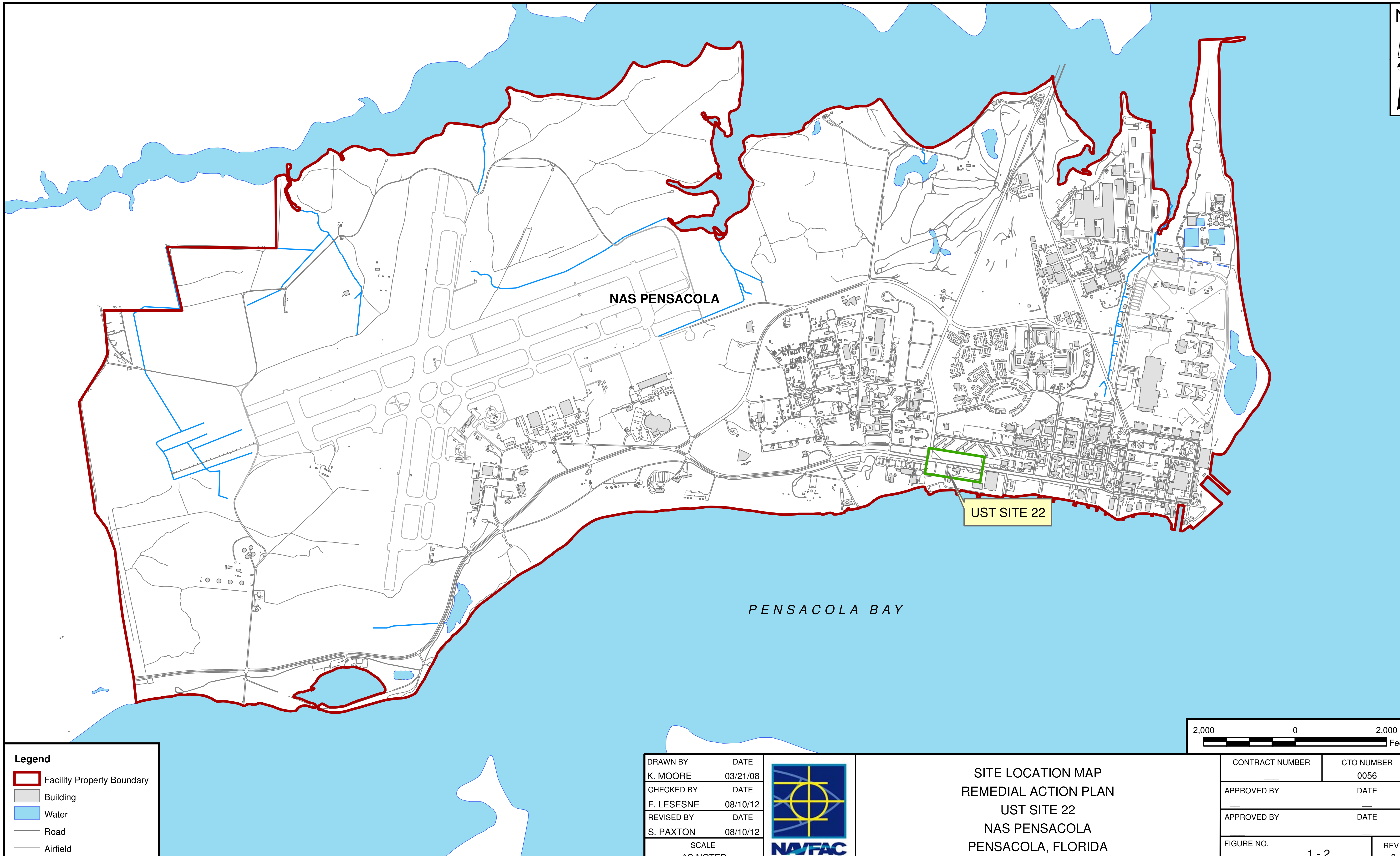
Section 1.0	**Introduction**	Summarizes the report's purpose, scope, site information, and report organization.
Section 2.0	**Previous Investigations**	Provides information from the approved Contamination Assessment Report (CAR) and Site Assessment Report Addendums (SARAs), and summarizes findings and conclusions.
Section 3.0	**RAP Goals**	Establishes cleanup goals and objectives for the petroleum related constituents in soil and groundwater at the Site.
Section 4.0	**Contaminant Distribution**	Estimates the volumes of soil and groundwater contamination present at the Site.
Section 5.0	**Remedial Design and Evaluation**	Presents the conceptual design of the preferred remedial alternatives.
Section 6.0	**Groundwater Monitoring Plan**	Provides a monitoring plan for evaluating the effectiveness of the remedial alternatives.
	References	Lists references used in preparation of this RAP.
	Appendix A	Contains the soil and groundwater contaminant mass and volume calculation sheets.
	Appendix B	Provides the cost estimate for the selected remedial alternatives.
	Appendix C	Provides the Environmental Footprint Evaluation report.
	Appendix D	Contains the RAP summary sheet and checklist.

PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\FACILITY_LOCATION_MAP.MXD 6/11/2012 JN



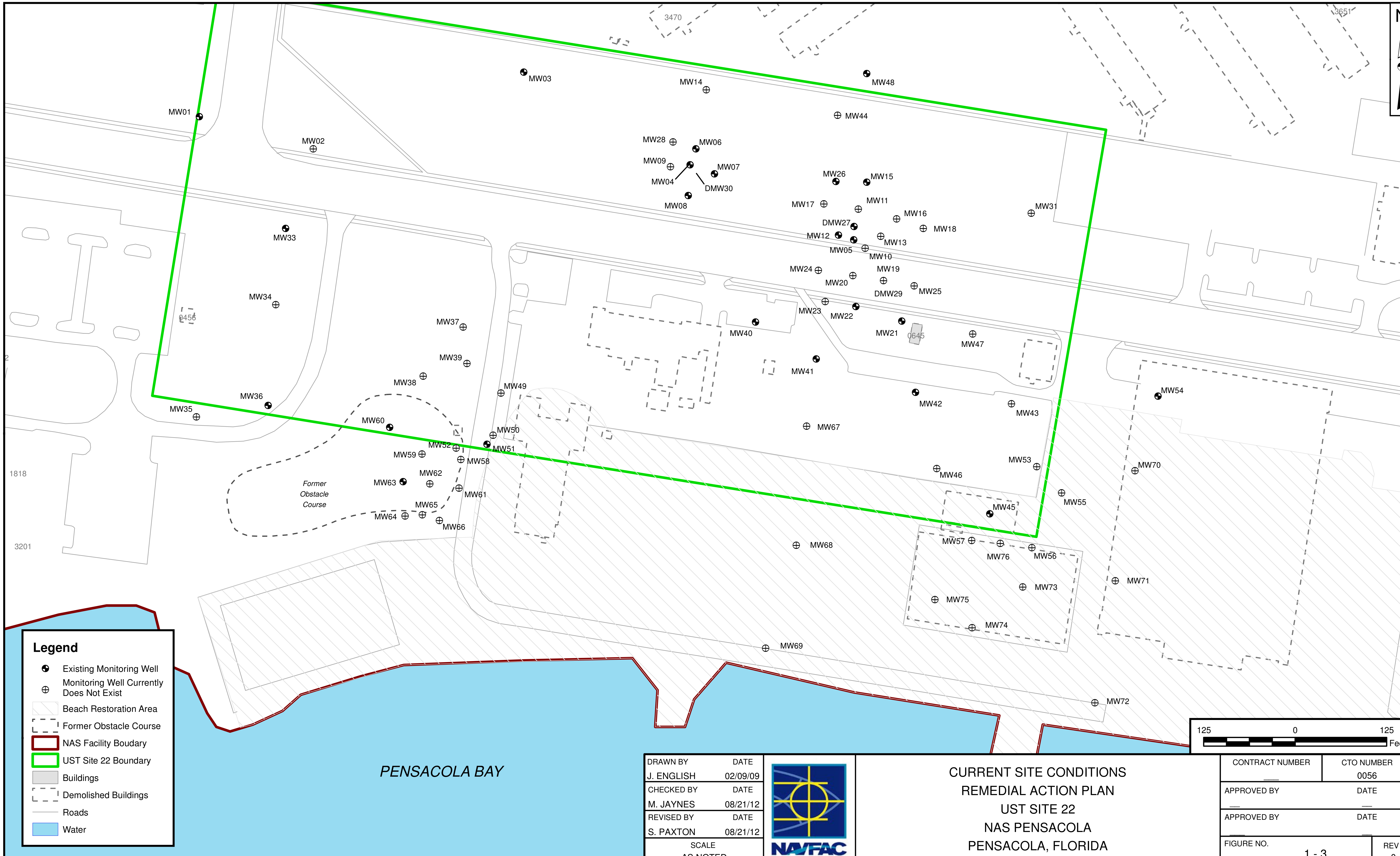
DRAWN BY K. MOORE	DATE 07/14/08	NAVFAC	FACILITY LOCATION MAP REMEDIAL ACTION PLAN UST SITE 22 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER CTO 0056
CHECKED BY M. JAYNES	DATE 06/11/12			APPROVED BY ___ DATE ___
REVISED BY J. NOVAK	DATE 06/11/12			APPROVED BY ___ DATE ___
SCALE AS NOTED				FIGURE NO. FIGURE 1-1 REV 0

PGH P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\LOCATION_MAP.MXD 08/10/12 SP



DRAWN BY K. MOORE	DATE 03/21/08	NAVFAC	SITE LOCATION MAP REMEDIAL ACTION PLAN UST SITE 22 NAS PENSACOLA PENSACOLA, FLORIDA	CONTRACT NUMBER —	CTO NUMBER 0056
CHECKED BY F. LESESNE	DATE 08/10/12			APPROVED BY —	DATE —
REVISED BY S. PAXTON	DATE 08/10/12			APPROVED BY —	DATE —
SCALE AS NOTED				FIGURE NO. 1 - 2	REV 0

PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22_WORK_AREAS_LAYOUT.MXD 8/21/2012 SP



2.0 PREVIOUS INVESTIGATIONS

The following is a summary of the data and information presented in the CAR [Navy Public Works Center (PWC), 1997]; and SARA I, SARA II, and SARA III (Tetra Tech, 2001, 2003, and 2011, respectively).

2.1 PREVIOUS INVESTIGATIONS

Previous investigations at UST Site 22 include the Phase I IR assessment conducted in 1991 (Ecology and Environment, 1991), the Contamination Assessment completed in 1997 (PWC, 1997), and the three additional site assessments (SARA I (Tetra Tech 2001), SARA II (Tetra Tech 2003), and SARA III Tetra Tech 2012), completed in 2001, 2003, and 2011, respectively). Also, it should be noted that throughout the history of investigations at this Site, Florida revised soil and groundwater screening/regulatory criteria. Revisions were made to the screening criteria on May 26, 1999 and April 17, 2005. The resulting target levels were only slightly different from those in the previous edition of the rules. The data collected during each segment of the study were compared to the most current criteria available at the time. Figure 2-1 presents soil and groundwater sampling locations for the assessment activities conducted at UST Site 22 during the initial Contamination Assessment in 1997 and the three SARAs that concluded in 2011.

2.1.1 Phase I IR assessment

The activities for the Phase I IR assessment included collecting soil samples from 18 soil borings, installing and sampling 5 temporary monitoring wells, and conducting a soil headspace survey. Concentrations of chromium, zinc, lead, copper, total xylenes, phenol, and TRPH were detected in the groundwater samples. However, only concentrations of zinc, lead, and TRPH exceeded their Florida Primary Drinking Water Standards that were in effect in 1991. In addition, TRPH was detected in soil samples from 7 of the 18 borings; one sample had elevated concentrations of PAH. Also, a thin layer of free-phase product or petroleum sheen was detected; however, this sheen has not been observed during any subsequent investigation.

2.1.2 Contamination Assessment - 1997

In June 1997, the NAS Pensacola Navy PWC submitted a Contamination Assessment Report (CAR) to summarize the additional investigation that was conducted to address the findings of the IR assessment. The additional investigation included advancing 113 soil borings and analyzing soil samples using an organic vapor analyzer (OVA), and installing and sampling 25 shallow monitoring wells. Concentrations of TRPH, volatile organic compounds (VOCs), PAHs, and lead were detected in soil and groundwater samples at concentrations above Florida regulatory limits in effect at that time. Based on the results, the

CAR recommended No Further Action (NFA) for the Site soils, and proposed Monitoring Only for PAHs, TRPH and lead in groundwater.

2.1.3 SARA I

Following the CAR, the FDEP requested that an additional site assessment be completed to meet the requirements of Chapter 62-770, F.A.C. The SARA I field investigation was conducted from May to July 2000. The investigation targeted areas where petroleum-related constituent concentrations in soil and groundwater exceeded regulatory criteria. The SARA I activities began with the collection of soil gas headspace samples from 15 hand auger soil boring locations. Field screening for “Excessively Contaminated Soil” was conducted as specified in Petroleum Contamination Site Cleanup Criteria - Chapter 62-770 F.A.C.

Soil samples from three of the soil borings contained OVA headspace readings exceeding 50 parts per million (ppm). The highest OVA headspace reading, greater than 5,000 ppm, was detected in soil samples collected at a depth of 3 feet bls.

Sixteen confirmation soil samples were collected for laboratory analysis based on flame ionization detector (FID) headspace screening results, field observations and/or proximity to the historical high groundwater level (2 to 2.5 feet bls). One subsurface soil sample, HA02 at 5 feet bls, was reported to contain 12 PAHs at concentrations exceeding instrument detection limits. However, of the 12 PAHs detected in the sample, benzo(a)pyrene, was the only one detected at a concentration exceeding the Florida SCTL of 0.1 mg/kg for residential direct exposure at a depth of 5 feet bls. The detected concentration of benzo(a)pyrene was below the Florida SCTL of 8 mg/kg for leachability to groundwater. Therefore, benzo(a)pyrene is not considered a concern under a residential direct exposure and leaching to groundwater criteria.

Copper (187 mg/kg) and lead (664 mg/kg) were also detected in soil sample HA2 at 5 feet bls at concentrations exceeding their residential direct exposure SCTLs of 150 and 400 mg/kg, respectively. The sample was collected from 5 feet bls; therefore, residential direct exposure is not a significant concern.

TRPH was detected in 10 of the subsurface soil samples at concentrations ranging from 12.1 mg/kg to 9,820 mg/Kg. TRPH concentrations in two soil borings (HA07 at 4 feet bls and HA08 at 1 foot bls) exceeded the Florida residential direct exposure SCTL of 460 mg/kg and TRPH concentrations in two soil borings (HA06 at 6 feet bls and HA09 at 2.5 feet bls) exceeded the industrial direct exposure SCTL of 2,700 mg/kg. Each of these samples exceeded the leachability to groundwater SCTL of 340 mg/kg.

TRPH detected in soil samples above their SCTLs during the SARA I investigation are summarized below in Table 2-1 and presented on Figure 2-2.

Groundwater samples were collected from 23 existing monitoring wells at the Site, and analyzed for VOCs [including methyl tertiary-butyl ether (MTBE)], PAHs, TRPH, and total lead. Total xylenes, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, TRPH, and lead were detected above their Maximum Contaminant levels or Groundwater Cleanup Target Levels (GCTLs) (hereinafter GCTLs) per Chapter 62-550, F.A.C. or Chapter 62-777, F.A.C., respectively. Based on the additional data, the SARA I report recommended additional soil delineation and groundwater monitoring at the Site.

On April 20, 2001, FDEP issued a technical review letter agreeing with the SARA I recommendations, and requested that additional assessment be conducted at the Site before preparation of the RAP.

2.1.4 <u>SARA II</u>

In April 2003, Tetra Tech submitted a SARA II letter report to document additional field activities conducted between October 2002 and February 2003. The field activities included advancement of 33 soil borings for soil head space screening and soil sample collection, and installation of 12 monitoring wells for groundwater sampling.

Field headspace screening results indicated that petroleum impacted soil was present at the west end of the site, south of Radford Boulevard. Because the headspace screening detections were limited to samples collected from the intervals immediately above the water table,the soil contamination in this area (soil containing TRPH at depths below the historical high water table) most likely resulted from groundwater level fluctuations over time producing a smear zone of soil exposed to contaminated groundwater.

The soil samples were analyzed in the field by a mobile laboratory for benzene, ethylbenzene, toluene and xylene and five soil samples were sent offsite for analysis of volatile organics, PAHs, and TRPH. The volatile organics were detected in the field at low concentration below their SCTLs. One soil sample from boring DP26S, which was submitted for off-site analysis, contained nine PAHs, but only three (naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene) were detected above their leachability to groundwater SCTLs.

Two surface soil samples collected from the land surface to 2 feet bls in the area south of Building 670 had PAH detections at concentrations exceeding Florida SCTLs in effect at 2003. Surface soil sample SB27 contained benzo(a)pyrene at concentrations exceeding its residential direct exposure SCTL. The surface soil sample from SB29 had five PAHs (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluroanthene, dibenzo(a,h)anthracene, and indeno(1,2-cd)pyrene) at concentrations that exceeded their 2003 industrial direct exposure SCTLs. This sample would also exceed the current industrial direct exposure SCTL for benzo(a) pyrene toxicity equivalents. The SB29 soil boring location was the westernmost soil boring installed in this area during the SARA II investigation. Concentrations of lead and copper were below their SCTLs.

TRPH was detected in soil samples from 8 borings at depths that ranged from 2 to 3 feet bls and 4 to 6 feet bls, all below the historical high water table or within the smear zone. Two of the soil samples contained TRPH at concentrations that exceed the residential direct exposure SCTL of 460 mg/kg (SB09 at 2 to 3 feet bls and SB21 at 4 to 6 feet bls). Six of the soil samples contained TRPH at concentrations that exceed the industrial direct exposure SCTL of 2,700 mg/kg (SB08, SB13, and SB16 at 2 to 3 and SB11, SB15, and SB17 at 4 to 6 feet bls). Each of the soil samples contained TRPH at concentrations exceeding the leachability to groundwater SCTL of 340 mg/kg. The soils with TRPH above the Florida industrial direct exposure SCTL occur in the capillary fringe (area directly above the water table where moisture “wicks” upward due to capillary forces, leaving small amounts of water in the soil pore spaces above the water table) or below the water table and in contact with contaminated groundwater.

Three soil samples (SB11, SB16, and SB17) from this area were submitted for Synthetic Precipitation Leaching Procedure (SPLP) extraction for TRPH and TRPH total analysis. TRPH was below the laboratory detection limits in the SPLP extract for the three samples.

TRPH detected in soil samples above their respective SCTLs during the SARA II investigation are summarized below in Table 2-1 and presented on Figure 2-2.

Groundwater sampling was conducted at 12 existing monitoring wells (MW33 through MW44) during the SARA II investigation.

TRPH and lead were detected in groundwater samples above their GCTLs as summarized below in Table 2-2.

**TABLE 2-1
SOIL TRPH ANALYTICAL SUMMARY
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA**

					TRPH (mg/kg)
				Residential SCTL	460
				Industrial SCTL	2,700
				Leaching to Groundwater SCTL	340
Sample Location	**Sample ID**	**Sample Depth (feet)**	**Sample Date**	**OVA (ppm)**	
HA06	NASP21HA0606	5-6	5/8/2000	NA	**8,500**
HA07	NASP21HA0704	3-4	5/8/2000	NA	**620**
HA08	NASP21HA0801	0-1	5/8/2000	NA	**808**
HA09	NASP21HA092.5	2-3	5/8/2000	NA	**9,820**
SB02	PEN21SB0206	4-6	10/23/02	0.0	8.26J
SB04	PEN21SB0402	0-2	10/23/02	0.0	108
SB05	PEN21SB0503	2-3	10/23/02	0.0	23.6
SB07	PEN21SB0706	4-6	10/23/02	0.0	6.23J
SB08	PEN21SB0803	2-3	10/23/02	159.0	**4,460**
SB09	PEN21SB0903	2-3	10/23/02	249.3	**2,010**
SB11	PEN21SB1106	4-6	10/23/02	NA	**10,500**
SB12	PEN21SB1206	4-6	10/23/02	0.0	11.1
SB13	PEN21SB1304	2-4	10/23/02	2182	**20,600**
SB14	PEN21SB1404	2-4	10/23/02	NA	88.8
SB15	PEN21SB1506	4-6	10/24/02	129.4	**4,460**
SB16	PEN21SB1603	2-3	10/24/02	407.0	**10,800**
SB17	PEN21SB1706	4-6	10/24/02	1147	**2,840**
SB18	PEN21SB1806	4-6	10/24/02	0.0	< 6.9
SB19	PEN21SB1906	4-6	10/24/02	0.0	8.24J
SB21	PEN21SB2106	4-6	10/24/02	19.8	**471**
SB22	PEN21SB2206	4-6	10/24/02	NA	< 5.8
SB23	PEN21SB2306	4-6	10/24/02	0.0	7.43J

NOTES:
TRPH - Total Recoverable Petroleum Hydrocarbons
mg/kg - milligrams per kilogram.
SCTL - Soil Cleanup Target Level
OVA - Organic Vapor Analyzer
ppm - parts per million
GCTL - Groundwater Cleanup Target Level
NA – Not analyzed
J - estimated value below the practical quantitation limit
Values shown in bold are at concentrations exceeding one or more SCTL.

TABLE 2-2
SUMMARY OF 2003 SARA II GROUNDWATER ANALYTICAL RESULTS
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

Monitoring Well ID	Sample ID	Sample Date	Lead[1] GCTL (µg/L)	TRPH[2] GCTL (µg/L)
			15	5,000
MW33	PEN-21-MW33-01	2/11/03	NA	170 U
MW34	PEN-21-MW34-01	2/11/03	NA	285
MW35	PEN-21-MW35-01	2/11/03	NA	2,710 / 2,680
MW36	PEN-21-MW36-01	2/11/03	NA	1,900
MW37	PEN-21-MW37-01	2/11/03	NA	170 U
MW38	PEN-21-MW38-01	2/11/03	NA	894
MW39	PEN-21-MW39-01	2/11/03	NA	**7,090**
MW40	PEN-21-MW40-01	2/11/03	5.1	NA
MW41	PEN-21-MW41-01	2/11/03	6.5	NA
MW42	PEN-21-MW42-01	2/11/03	3.3 U / 4.1 U	NA
MW43	PEN-21-MW43-01	2/11/03	**22.9**	NA
MW44	PEN-21-MW44-01	2/11/03	5.0	NA

Notes:
[1]SW846-6010B [2] FL-PRO
GCTL = Groundwater Cleanup Target Level established in Chapter 62-770, FAC
U = analyte not detected above laboratory method detection limit.
NA = Location not analyzed for this parameter
Concentrations in bold exceed the GCTL.
Two values in one cell indicate duplicate sample

The SARA II recommended that additional site assessment be conducted and specifically recommended further delineation of TRPH and PAHs in soil, and lead in groundwater. The SARA II also recommended that once the contaminants were delineated, a RAP should be prepared to address dissolved lead contamination in groundwater. The source of the lead contamination in groundwater at the Site appears to be associated with former ASTs north of Radford Boulevard at the eastern perimeter of the Site. Although the ASTs were removed from the Site, it is unknown if any soils were excavated and disposed of during the tank removal. In addition, it was reported that the tanks were used to store AVGAS and were cleaned annually and the sludge from the bottoms of the tanks was disposed on the ground surface in the immediate vicinity of the tanks. Lead is a known constituent of AVGAS.

2.1.5 SARA III

Beginning in May 2007, Tetra Tech personnel conducted the first of two phases of field investigations as part of the SARA III (Tetra Tech, 2011). The first phase of the field events was conducted using a direct-push technology (DPT) rig to collect soil and groundwater samples. The soil and groundwater samples were analyzed on site using a mobile laboratory for benzene, ethylbenzene, toluene, xylenes (BTEX) and naphthalene. Five of the soil boring samples were sent to an off-site laboratory for confirmation analysis for VOCs, MTBE, PAHs, 1- and 2-methylnaphthalene, and TRPH. Based on the field screening results, eleven groundwater samples were sent to an off-site laboratory for confirmation analysis of various parameters including VOCs, MTBE, PAHs plus 1- and 2-methylnaphthalene, TRPH, and lead. The soil and groundwater data was used to select the locations for 16 new monitoring wells. In addition, three replacement monitoring wells were installed. After monitoring well installation, the new monitoring wells were developed and subsequently groundwater samples were collected using low flow purge and sample techniques from 23 existing monitoring wells, the 16 newly installed monitoring wells and the 3 replacement monitoring wells (42 total). Previous analytical data and site observations were used to select the target analytes for each monitoring well. The various analytes selected included target compound list (TCL) VOCs, PAHs, TRPH, and lead.

The second phase was conducted in 2009 and included collecting groundwater samples from 17 permanent monitoring wells based on the previous analytical data. The groundwater samples were analyzed for lead, manganese, and zinc, and the groundwater sample from one monitoring well (MW73) was analyzed for VOCs.

Soil Sample Results - 2007: DPT sampling techniques and the quick turn-around analysis from the on-site laboratory were used to define areas of soil contaminated with PAHs and TRPH in 2007. Only one sample, DP26S, located at the southwest portion of the site and collected from 6 to 8 feet bls, contained naphthalene at a concentration of 90 mg/kg in the on-site laboratory results. The residential direct exposure SCTL for naphthalene is 55 mg/kg. However, the fixed-base laboratory analytical results for DP26S were 3.5 and 4.1 mg/kg for two different dilutions, which are below the residential direct exposure SCTL but above the leachability to groundwater SCTL of 1.7 mg/kg.

In addition, soil sample DP26S also contained 1-methylnaphthalene (9.2 and 10.0 mg/kg for two different dilutions) and 2-methylnaphthalene (15.0 and 18.0 mg/kg for two different dilutions) at concentrations below their residential direct exposure SCTLs (200 and 210 mg/kg, respectively) but above their leachability to groundwater SCTLs (3.1 and 8.5 mg/kg, respectively).

Based on depth to water level measurements from monitoring wells MW-34, MW-35 and MW-36 in this area of the site, groundwater occurs from approximately 2.8 to 5.97 feet bls in the general vicinity of soil sample location DPT26S. Soil sample DP26S was collected from 6 to 8 feet bls and described on the field log as in the smear zone, therefore, the concentrations of naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene detected in this sample are likely due to the fluctuations of groundwater level.

DPT Groundwater Sample Results – 2007: Forty two DPT groundwater samples were analyzed on site by the mobile laboratory and 19 of those samples were sent to the off-site laboratory for confirmation. Benzene, toluene, ethylbenzene, xylenes (m&p-xylenes and o-xylenes) and naphthalene were detected in the groundwater samples. Benzene was detected in three groundwater samples at a concentration equal to its GCTL of 1 µg/L. Ethylbenzene was detected in four groundwater samples at concentrations that exceed its GCTL of 30 µg/L. Xylenes were detected in four groundwater samples at concentrations that exceed its GCTL of 20 µg/L. Naphthalene was detected in 10 groundwater samples at concentrations that exceed its GCTL of 14 µg/L.

However, the confirmation samples submitted to an offsite fixed-base laboratory did not confirm the results of the mobile laboratory analysis. Lead was detected in 10 DPT groundwater sample and total xylenes was detected in one sample (location DP39) at concentrations exceeding their GCTLs, but they were less than their NADCs.

Existing Monitoring Well Groundwater Re-sampling Results - 2007: Twenty-three existing monitoring wells and three replacement monitoring wells were sampled for specific parameters based on previous investigations and FDEP comments. The groundwater samples from existing monitoring wells contained TRPH (nine locations), xylenes (four locations), ethylbenzene (three locations), benzo(a)anthracene (1 location), benzo(b)fluoranthene (one location), dibenzo(a,h)anthracene (one location), naphthalene (six locations), 1-methylnaphthalene (five locations), 2-methylnaphthalene (five locations), and lead (24 locations), at concentrations that exceeded their GCTLs. Groundwater samples from three locations contained lead at concentrations that exceeded its NADC (Figure 2-2).

New Monitoring Well Groundwater Sampling Results - 2007: The groundwater samples collected in 2007 contained ethylbenzene, xylenes, benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, naphthalene, 1-methylnaphthalene and 2-methylnaphthalene, TRPH, and lead at concentrations exceeding their GCTLs (Figure 2-2). Ethylbenzene, naphthalene, and lead were detected at concentrations that exceed their NADCs.

Ethylbenzene and xylenes were detected in groundwater samples from monitoring wells MW-73, MW-74 and MW-76 at the southeast area of the site at concentrations exceeding their GCTLs. Ethylbenzene exceeded its NADC at one well location (MW-73), and xylenes equaled its NADC at one location (MW-

76). Monitoring well MW-75, also at the southeast area of the site, contained benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene at concentrations that exceeded their GCTLs.

Groundwater samples from monitoring wells in the southwest portion of the site contained naphthalene, 1-methylnaphthalene, 2-methylnaphthalene and TRPH at concentrations that exceeded their GCTLs. Naphthalene was detected at six monitoring well locations wells at concentrations exceeding its GCTL and at one location exceeding its NADC. 1-methylnaphthalene and 2-methylnaphthalene were detected at five monitoring well locations wells at concentrations exceeding their GCTLs, none of the groundwater samples contained the chemicals at concentrations exceeding their NADCs. TRPH was at detected at nine monitoring well locations at concentrations exceeding its GCTL, none of the groundwater samples contained TRPH at concentrations exceeding its NADC.

Groundwater samples from 21 monitoring well locations contained lead at concentrations exceeding its GCTL and samples from three locations exceeded its NADC.

2009 Monitoring Well Groundwater Sample Results – 2009: Seventeen monitoring wells were sampled during the January 2009 event. Lead (ten monitoring well locations), manganese (four monitoring well locations), ethylbenzene (one monitoring well location), and xylenes (one monitoring well location) were detected at concentrations greater than their respective GCTLs (Figure 2-3). Lead exceeded its NADC at one monitoring well location. Additionally, regulatory criteria have not been established for manganese for Predominantly Marine Waters per Chapter 62-302, F.A.C.

Statistical Evaluation of Lead in Groundwater: The groundwater sample results for lead from the SARA III investigation were compared to previous investigations; no apparent trend or pattern was observed. However, because of the inconsistency in reported lead concentrations, it was theorized that there could be an external source, not related to the Site use, affecting the area and the reported concentrations for lead, therefore, a statistical evaluation was conducted to determine if the lead in the groundwater was naturally occurring or anthropogenic (Tetra Tech, 2012).

The statistical evaluation indicated that the lead data exhibits a positively-skewed lognormal or gamma distribution which could be indicative of true contamination, or it could represent a natural environmental distribution in which samples are elevated due to natural variations. Therefore, lead concentrations were compared to manganese concentrations to determine if there was a positive correlation thereby indicating a natural geochemical occurrence. Also, manganese was compared with zinc to verify that its concentrations were also a natural geochemical occurrence. The evaluation did not find a significant correlation between lead and manganese or manganese and zinc. Interpretation of this statistical evaluation suggests that lead concentrations could be site related. Additionally, the evaluation of a trend in lead concentrations by the Mann-Kendall test suggest that a significant trend was not present at an 80 percent confidence level, that no significant attenuation was apparent, and the lead concentrations appeared to be stable. The data evaluation also suggests that fluctuations in the lead concentrations were likely due to natural environmental conditions in a complex geochemical system. In addition, the Kolmogorov-Smirnoff statistical test was conducted at a 95 percent level of significance to determine the presence or absence of a significant trend. The results of this statistical evaluation suggests that monitoring well locations MW-2, MW-4 and MW-11 were data outliers and could be considered as potential source areas.

2.1.6 <u>Site Assessment Recommendations</u>

In accordance with the conclusions in the SARA I, SARA II and with the results of the investigations from SARA III, Tetra Tech recommended that a RAP be completed to address the TRPH contaminated soils and groundwater at UST Site 22. In addition to the proposed RAP, confirmatory groundwater sampling should be conducted to verify the concentrations of ethylbenzene and inconsistencies between the concentrations of lead in groundwater; and confirmatory soil sampling should be conducted around soil sample location DP26SB29 because of the detection of PAHs at concentrations exceeding Florida SCTLs prior to remedial plan design.

Inorganic petroleum-related constituents comprise two separate plumes of groundwater exceeding the GCTL across the southern portion of the site. The plumes appear to originate from two former AST locations. The delineated plumes cover approximately two acres in total area. Monitoring only is recommended for these locations since exposure is unlikely and due to the delicate nature of the restored landscape in those areas.

Groundwater data for lead at UST Site 22 was from multiple sampling events with minimal overlap of the monitoring wells sampled. Interpretation of laboratory analytical data from the multiple sampling events suggests that there is considerable variability in the concentration of lead. A statistical evaluation of the UST Site 22 laboratory analytical data for lead indicates that the lead data exhibits a positively-skewed lognormal or gamma distribution which could be indicative of true contamination, or it could represent a natural environmental distribution in which samples are elevated due to natural variations. A comparison of lead and manganese concentrations, and manganese and zinc concentrations was also conducted but did not find a significant correlation between these inorganics. Therefore, interpretation of this statistical evaluation suggests that lead concentrations could be site related. In addition, the Kolmogorov-Smirnoff statistical test results suggests that monitoring well locations MW-2, MW-4 and MW-11 are data outliers and could be considered as potential source areas.

Exceedances of the GCTLs for lead and manganese were encountered during the study. Also, there was an exceedance of the NADC criteria for lead at monitoring well MW11, a monitoring well located at the edge or immediately downgradient of a former AST. Tetra Tech recommends groundwater monitoring only. However, due to the erratic nature of the lead exceedances, the number of monitoring well locations to be sampled should include at least one event for all on-site monitoring wells that had a detection of lead at concentrations exceeding its GCTL. This has not previously occurred and would give an overall representation of lead concentrations in groundwater across the site. Furthermore monitoring could be adjusted based on results of this event. In addition, an upgradient monitoring well should be designated as a site–specific background location for comparison of future groundwater sampling events.

Quarterly monitoring is the preferred method to determine the current nature and extent of lead in groundwater at UST Site 22 and determine if it is discharging to Pensacola Bay at concentrations that exceed Florida surface water quality criteria. The quarterly monitoring should include existing monitoring wells (after conducting a well inventory) and newly installed shallow and deep monitoring wells at hydraulic downgradient locations near the seawall, and hydraulic sidegradient to define the lateral edge of the lead plume.

The water level and laboratory analytical data collected from quarterly monitoring of shallow and deep monitoring wells at UST Site 22 will be used to gather sufficient data to evaluate groundwater flow characteristics, the horizontal and vertical extent of the lead plume in the vicinity of the sea wall, and the potential for groundwater containing lead to flow beneath the seawall at concentrations that exceed marine surface water criteria per Chapter 62-777, F.A.C. and/or Chapter 62-302, F.A.C. The quarterly monitoring data would be used to evaluate whether the seawall provides an effective engineering control for keeping the lead impacted groundwater from discharging into Pensacola Bay.

Additionally, the quarterly monitoring data will be evaluated using statistical analysis (such as the Mann-Kendall Test) to determine the trend (no trend, increasing or decreasing) in the concentrations of lead at UST Site 22. This data will also be used to determine if a potential source area(s) is present. If quarterly monitoring data indicates that a source area(s) is potentially present and contributing to the concentrations of lead in groundwater, then additional soil sampling would be conducted to: evaluate the site specific lead concentrations in soils above the water table; develop site specific leaching to groundwater concentration; and determine if a source removal action may be necessary.

Further monitoring could be adjusted based on results of the quarterly monitoring events. In addition, an upgradient monitoring well should be designated as a site–specific background location for comparison of the analytical results of future groundwater sampling events.

2.2 SITE LITHOLOGY

The surficial geology of the Site 22 area consists of Pleistocene marine deposits made up of light brown to tan, fine quartz sand with associated stringers and lenses of gravel and clay. Underlying these deposits, increasing with age, are the Citronelle Formation, the Miocene Coarse Clastics, the Pensacola Clay, the Tampa Formation, the Chickasawhay Limestone, the Bucatunna Clay member of the Byram Formation, the Ocala Group, the Lisbon equivalent, the Tallahatta Formation, and the Hatchetigbee Formation.

Based on the previous subsurface investigations conducted at NAS Pensacola, including Geraghty and Miller, Inc. (1986), and Ecology and Environment, Inc. (E&E, 1991), the stratigraphy from 0 to 100 feet below land surface (bls) at the facility consists of the following:

- An approximately 50-feet thick upper unit composed of fine to medium-grained quartz sand with abundant shell material and localized thin layers of silty clay.
- An approximately 15-feet thick, blue to green marine clay that is laterally persistent across the facility and serves as an aquitard, inhibiting groundwater movement between the units above and below it.
- An underlying unit composed of a complex mosaic of fine to coarse marine and fluvial sands with localized marine and fluvial clays.

Soil boring logs and regional lithology information are provided in all three SARAs.

2.3 AQUIFER CHARACTERISTICS

During all previous SA events/activities, hydrogeologic data were collected to evaluate depth and movement of groundwater in the surficial aquifer at Site 22.

2.3.1 Static Water Level and Groundwater Elevations

The most recent on-site depth-to-water (DTW) measurements and groundwater elevation determinations were recorded from site monitoring wells on January 6, 2009 (Figure 2-4). The DTW measurement data and the relative elevations from the top of casing (TOC) survey were used to determine relative groundwater elevations at each monitoring well. Historical water level measurements are compiled and provided in SARA III (Tetra Tech, 2011).

2.3.2 Groundwater Flow Direction

During each phase of assessment at UST Site 22, DTW and groundwater elevations (mean sea level) were used to determine the groundwater flow direction at the Site. According to the most recent measurements recorded in January 2009, the groundwater flow is to the southeast. However, because of the proximity of Pensacola Bay, tidal influences and various irrigation systems affect the Site hydrogeology over time and create seasonal changes.

2.3.3 Aquifer Characteristics

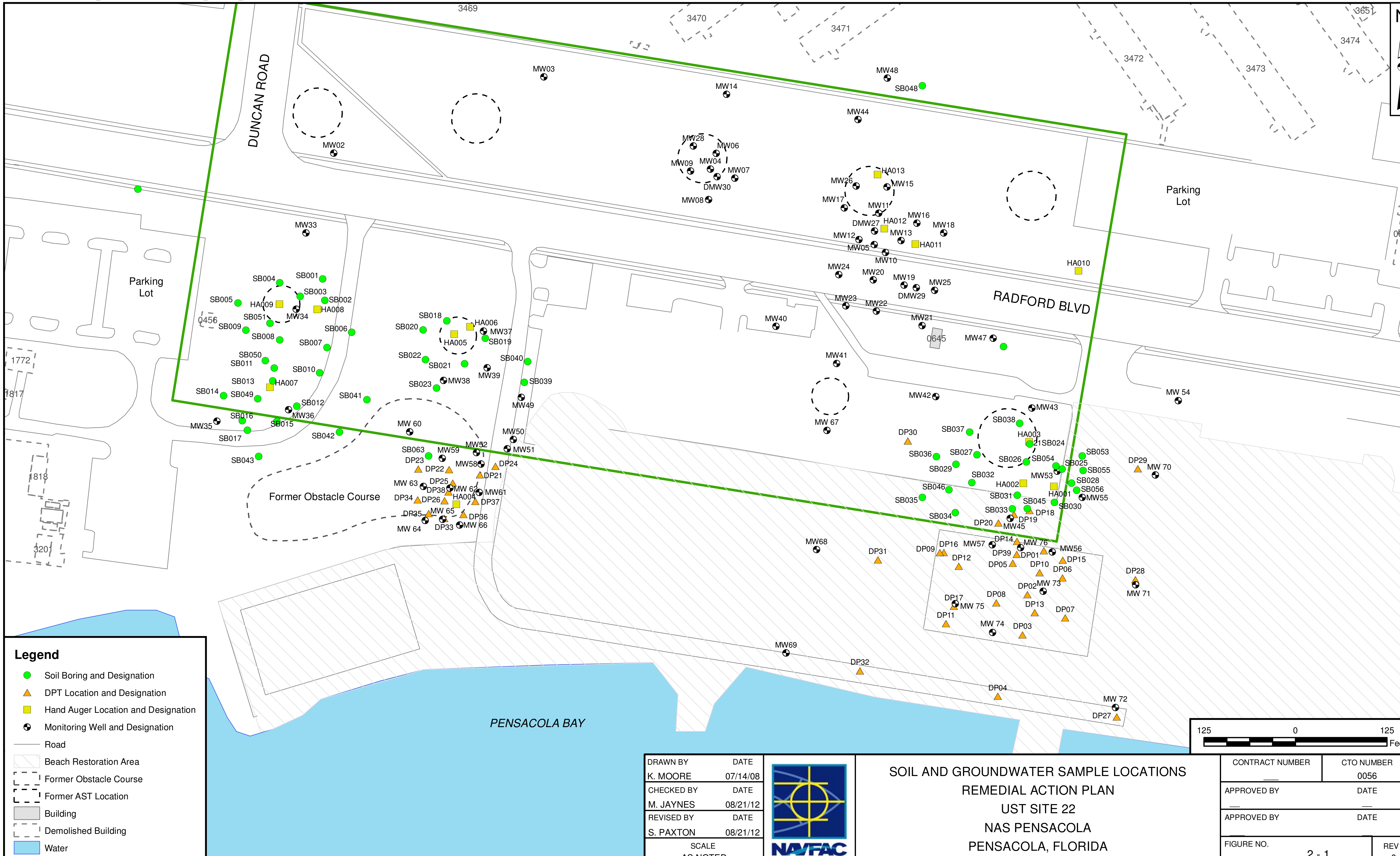
During SARA I activities conducted in June and July 2000, the average horizontal groundwater gradient across the Site was calculated from the groundwater elevations measured in shallow monitoring wells and the estimated groundwater flow direction. In addition, rising-head slug tests were conducted in select site monitoring wells to provide data to estimate the hydraulic conductivity (K) in the surficial aquifer. The slug test results are summarized in the SARA I (Tetra Tech, 2001).

Using an average horizontal hydraulic gradient (i) of 0.0021 feet/foot, a hydraulic conductivity of 5.2587 X 10^{-5} feet/sec, and an effective porosity of 0.15, the calculated groundwater seepage velocity was approximately 23.21 feet/yr. The calculation of this velocity did not take into consideration natural processes that effect groundwater movement such as advection, dispersion, and retardation. The groundwater aquifer characteristics estimated in the initial SARA are summarized below:

- Hydraulic conductivity K = 5.2587 X 10^{-5} feet/sec
- Horizontal Hydraulic gradient i = 0.0021 feet/foot
- Groundwater Seepage Velocity V = 23.21 feet/year
- Effective Porosity ne = 0.15 (unitless)

Slug test data logs, seepage velocity calculations, and hydraulic gradient calculations are provided in Attachment E of SARA I (Tetra Tech, 2001).

PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE21_SAMPLE_LOCS.MXD 8/21/2012 JN

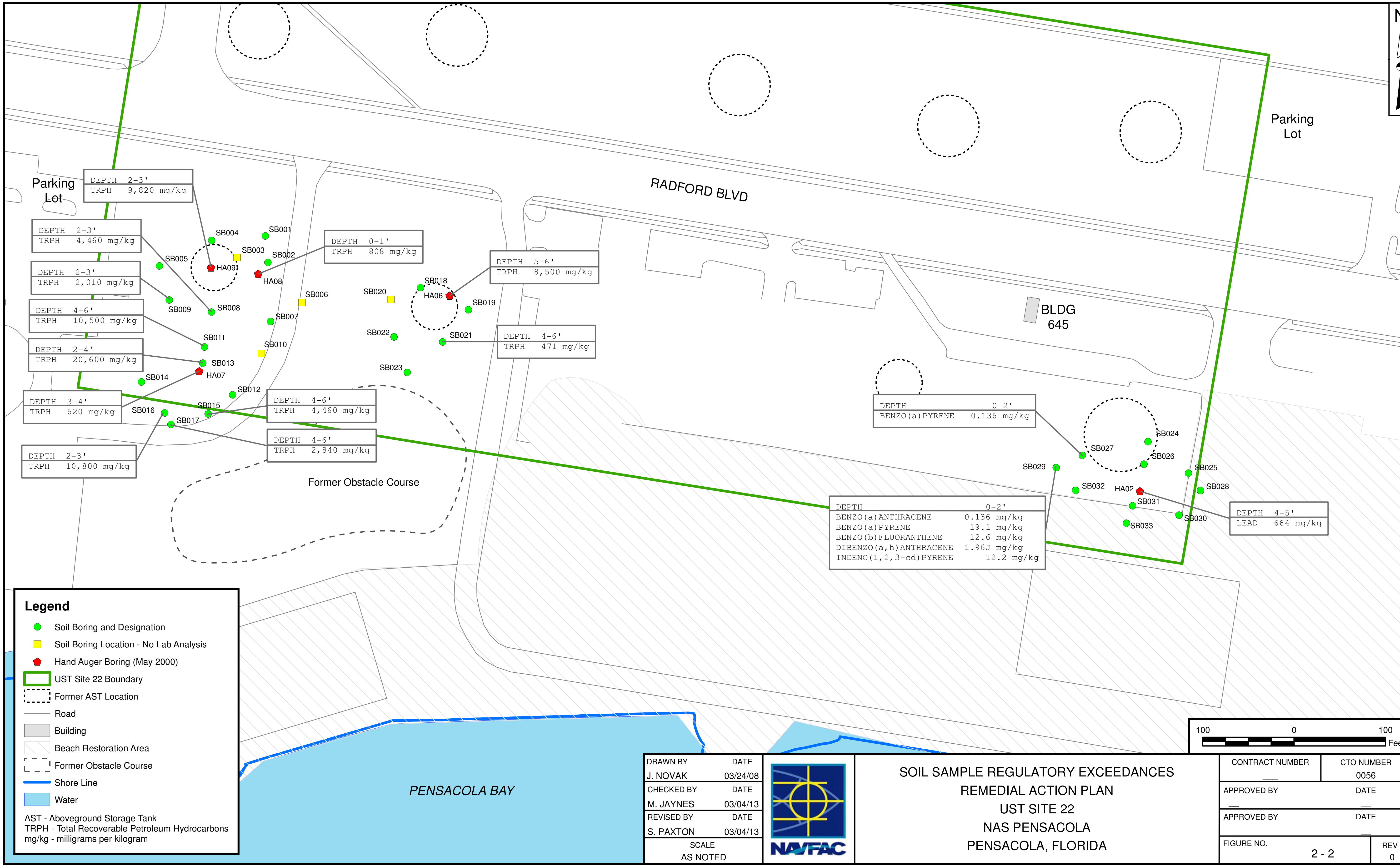


DRAWN BY	DATE
K. MOORE	07/14/08
CHECKED BY	DATE
M. JAYNES	08/21/12
REVISED BY	DATE
S. PAXTON	08/21/12
SCALE AS NOTED	

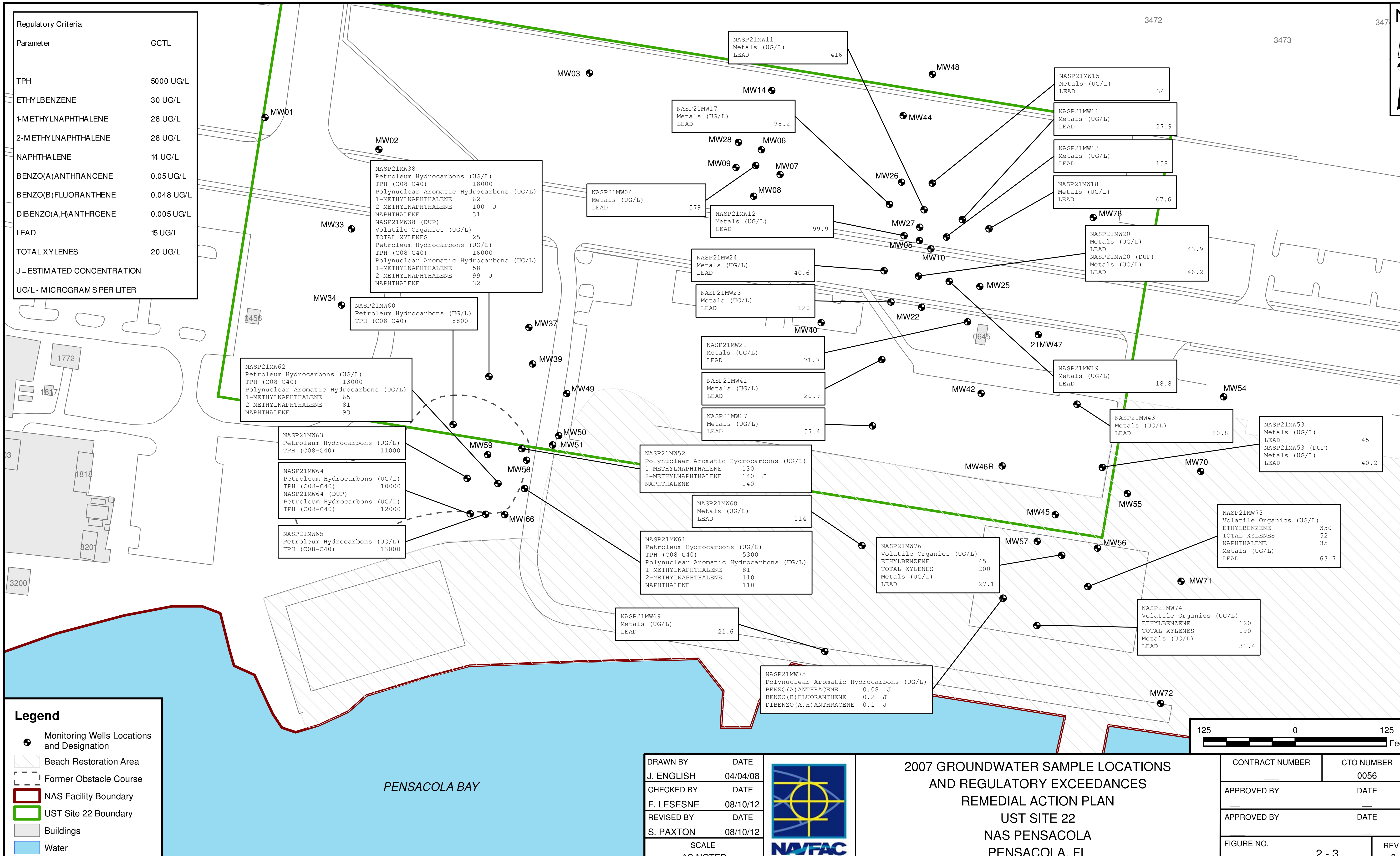
SOIL AND GROUNDWATER SAMPLE LOCATIONS
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
—	0056
APPROVED BY	DATE
—	—
APPROVED BY	DATE
—	—
FIGURE NO. 2 - 1	REV 0

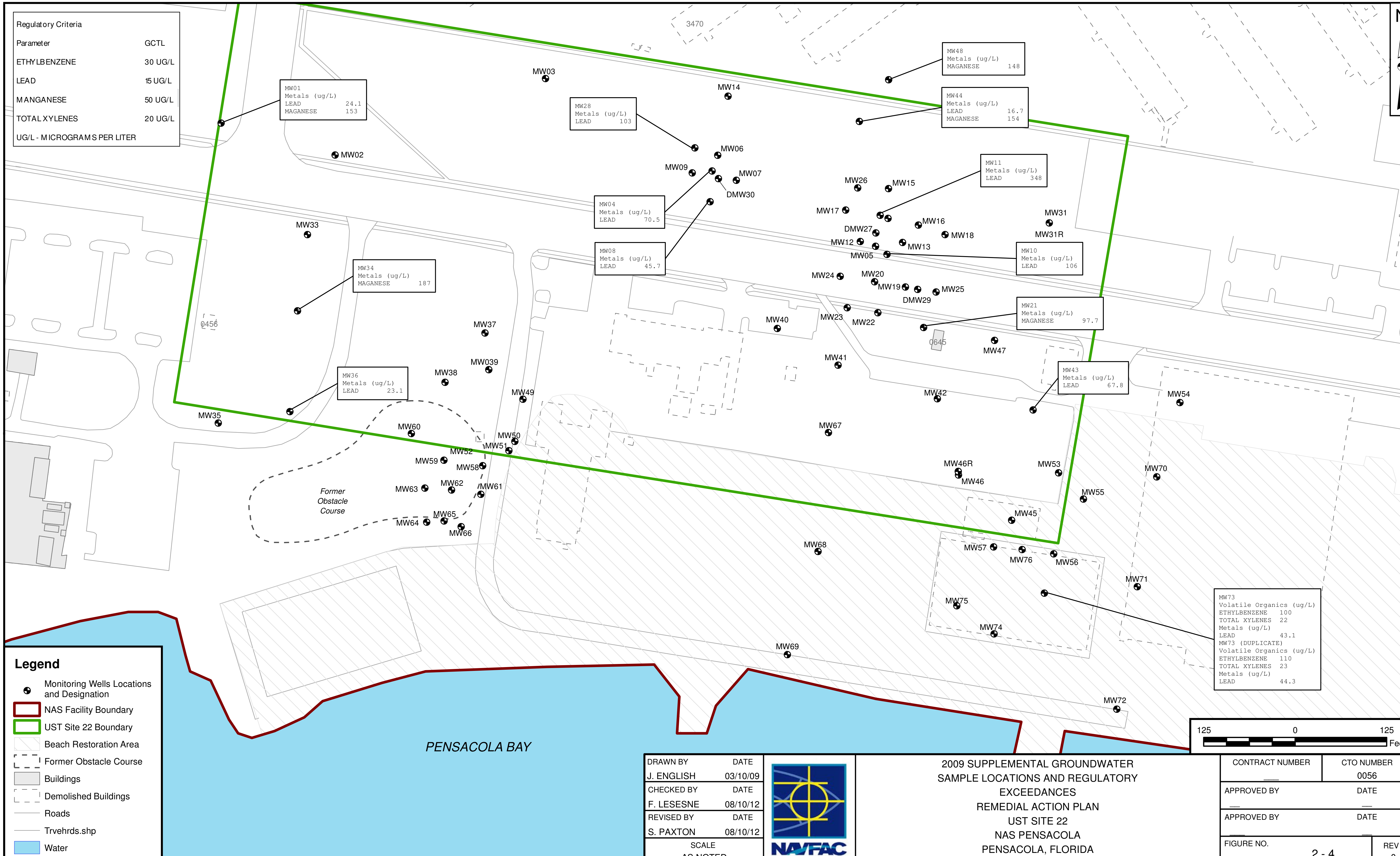
PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE21_RAP.MXD 3/4/2013 SP



PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22 MW TAGS LAYOUT.MXD 8/10/2012 SP



PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22 MW JAN 2009 TAGS LAYOUT.MXD 8/10/2012 SP



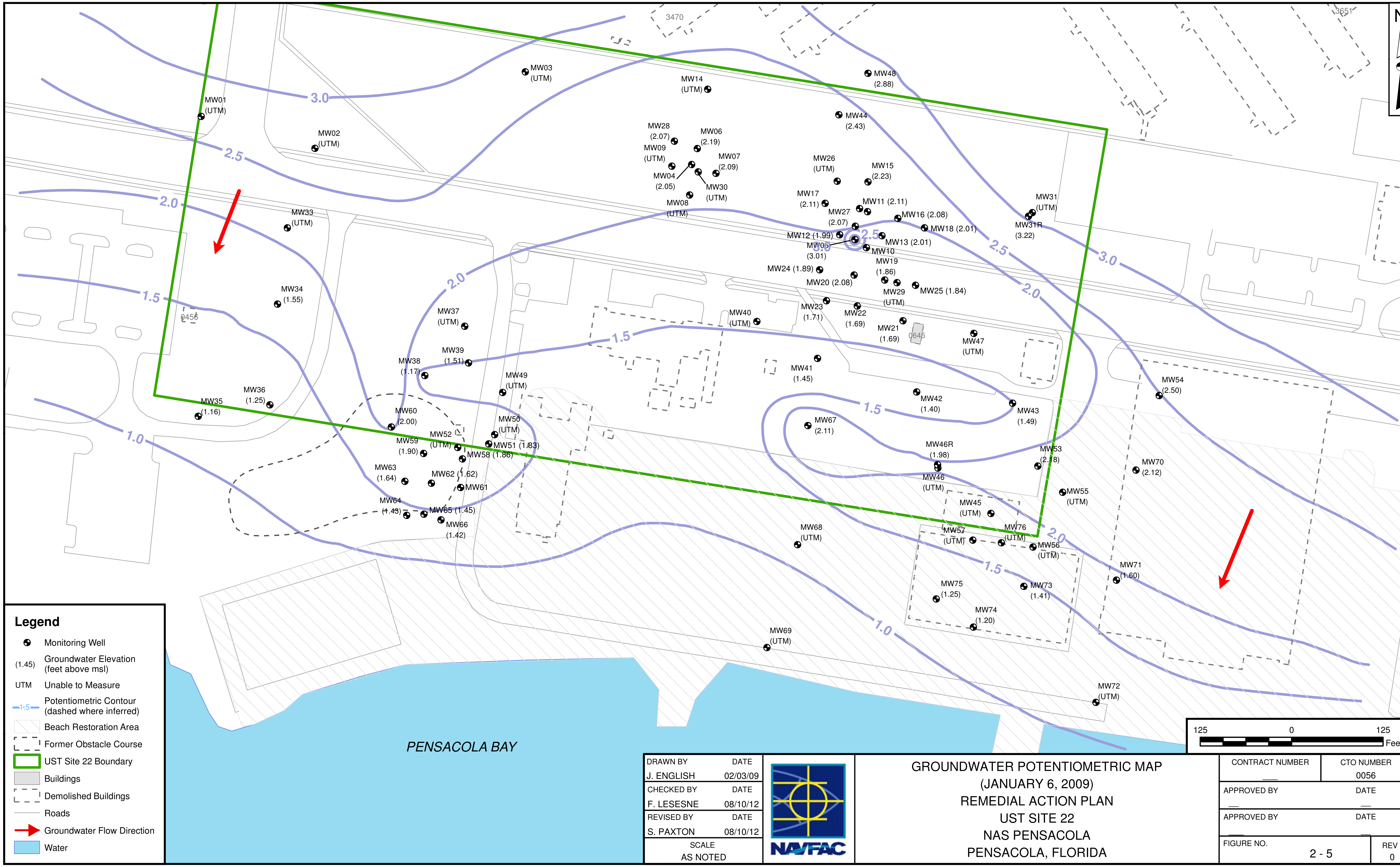
DRAWN BY	DATE
J. ENGLISH	03/10/09
CHECKED BY	DATE
F. LESESNE	08/10/12
REVISED BY	DATE
S. PAXTON	08/10/12
SCALE	
AS NOTED	

NAVFAC

2009 SUPPLEMENTAL GROUNDWATER
SAMPLE LOCATIONS AND REGULATORY
EXCEEDANCES
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
	0056
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. 2 - 4	REV 0

PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22 MW LOCATIONS LAYOUT.MXD 8/10/2012 SP



3.0 REMEDIAL ACTION PLAN GOALS

As discussed in Section 1.0, the objective of this RAP are to address existing soil (above the water table) containing TRPH and PAHs exceeding Florida industrial direct exposure SCTLs at the Site, evaluate the effectiveness of current engineering controls (the seawall) at the Site for the containment of lead contamination in groundwater, to assess MNA as a viable remedial option to address ethylbenzene, xylenes, 1-metyhlnaphthalene, 2-methylnaphthalene, naphthalene, TRPH, manganese and lead in groundwater, and to assess future remedial alternatives as contingencies for UST Site 22. To address these issues, cleanup goals have been established that will be used to evaluate soil and groundwater confirmation sample data and monitoring data to determine if the objectives of the RAP have been met.

Tables 3-1, 3-2 and 3-3 present soil, groundwater and surface water remediation goals for the Site-specific chemicals of concern (COCs) at UST Site 22. The evaluation of whether the RAP objectives have been met will be made by comparing site COC concentrations to these goals. The soil cleanup goals are based on the Florida SCTLs per Chapter 62-777, F.A.C. and groundwater cleanup goals are based on the Florida GCTLs per Chapter 62-550, F.A.C. and Chapter 62-777, F.A.C. The surface water cleanup goal is based on Florida predominantly marine surface water quality criteria per chapter 62-302, F.A.C.

TABLE 3-1

COC CLEANUP GOALS FOR SOIL

REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

COC	Exposure Pathway	FDEP SCTLs[1]
Benzo(a)anthracene	LGW	0.8 mg/kg
Benzo(a)pyrene	IDE[2]	0.7 mg/kg
Benzo(a)fluoranthene	LGW	2.4 mg/kg
Dibenzo(a,h)anthracene	LGW	0.7 mg/kg
Indeno(1,2,3-cd)pyrene	LGW	6.6 mg/kg
TRPH	IDE	2,700 mg/kg

Notes:
mg/kg = milligrams per kilogram
[1]SCTL = Soil Cleanup Target Level per Chapter 62-777, F.A.C.
[2]Individual Industrial Direct Exposure SCTL for benzo(a)pyrene and the Toxicity Equivalent factor for the carcinogenic polynuclear aromatic hydrocarbons including: benzo(a)anthracene, benzo(a)fluoranthene, dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene
IDE = Industrial Direct Exposure
LGW = Leachability to Groundwater

TABLE 3-2

COC CLEANUP GOALS FOR GROUNDWATER

REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

COC	Florida GCTLs[1]
Ethylbenzene	30 µg/L
Total Xylenes	20 µg/L
1-methylnaphthalene	28 µg/L
2-methylnaphthalene	28 µg/L
Naphthalene	14 µg/L
TRPH	5,000 µg/L
Lead	15 µg/L
Manganese	50 µg/L

Notes:
µg/L = micrograms per liter
NA = Not Available, Refer to Florida GCTL
[1]GCTL = Groundwater Cleanup Target Level per Chapter 62-550, F.A.C. or Chapter 62-777, F.A.C.

TABLE 3-3

COC CLEANUP GOALS FOR SURFACE WATER

REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

COC	Marine Surface Water Criteria[1]
Lead	8.5

Notes:
µg/L = micrograms per liter
[1]Predominantly Marine Surface Water Quality Criteria per Chapter 62-302, F.A.C.

4.0 CONTAMINANT DISTRIBUTION

Because of the nature of the proposed remedial actions described in this RAP for UST Site 22, these calculations are broad and approximate. If in the future, other active remedies or additional removal actions are required, then the contaminant mass and volume calculations will be updated with current and specific data. Calculations for the estimated volume and mass of affected soil and groundwater are presented in Appendix A.

4.1 ESTIMATED MASS OF CONTAMINATED SOIL

The estimated mass of contaminated/impacted soil was calculated for Site 22. The estimated area of soil contamination was separated into the following categories:

- TRPH in soil exceeding residential direct exposure SCTLs
- TRPH in soil exceeding industrial direct exposure SCTLs
- Lead, copper and PAHs in soil exceeding residential direct exposure SCTLs
- PAHs in soil exceeding industrial direct exposure SCTLs

The volume and mass of each category of impacted soil were calculated using the areas indicated on Figure 4-1. The square footage of each respective area was obtained based on the isocontour or outline of each area (S1 through S8) and using a Computer Aided Design (CAD) software program to calculate the total area within the contours.

An average depth of approximately 4 feet bls (3 feet bls for PAHs) across each impacted area (based on data from the SARAs) was assumed. The volume in cubic yards (yds^3) of each soil direct exposure category as described above was calculated by multiplying the sum of the areas in each category by the average depth. The respective volumes for the four categories of soil are as follows:

- TRPH in soil exceeding residential direct exposure SCTLs = 3,021 yds^3
- TRPH in soil exceeding industrial direct exposure SCTLs = 818 yds^3
- Lead, copper and PAHs in soil exceeding residential direct exposure SCTLs = 970 yds^3
- PAHs in soil exceeding industrial direct exposure SCTLs = 140 yds^3

The volume of each area was then used to calculate the mass (in tons) of impacted soil using the following equation:

$$\text{Mass} = \text{Volume ft}^3 \times \frac{1\,\text{yd}^3}{27\,\text{ft}^3} \times \frac{1.4\,\text{tons}}{1\,\text{yd}^3}$$

The respective mass for the three categories of soil are as follows:

- TRPH in soil exceeding residential direct exposure SCTLs = 4,230 tons
- TRPH in soil exceeding industrial direct exposure SCTLs = 1,145 tons
- Lead, copper and PAHs in soil exceeding residential direct exposure SCTLs = 1,359 tons
- PAHs in soil exceeding industrial direct exposure SCTLs = 195 tons

4.2 ESTIMATED VOLUME OF CONTAMINATED GROUNDWATER

The estimated volume of contaminated groundwater was calculated for Site 22. The estimated area of groundwater contamination was separated into the following categories:

- Petroleum constituents in groundwater exceeding GCTLs
- Lead in groundwater exceeding GCTLs
- Lead in groundwater exceeding NADCs

The volume of each category of impacted groundwater was calculated using the areas indicated on Figure 4-1 (isoconcentration lines). The square footage of each respective area was obtained based on the isocontour or outline of each area (G1 through G5) and using the CAD software program to calculate the total area within the contours.

An affected thickness of groundwater contamination of approximately 15 feet (based on data from the SARAs) was assumed. The volume in cubic feet (ft^3) of each groundwater category was calculated by multiplying the sum of the areas in each category by the average thickness and porosity (approximately 15%). The respective volumes for the three categories of groundwater are as follows:

- Petroleum constituents in groundwater exceeding GCTLs = 1,264,995 ft^3
- Lead in groundwater exceeding GCTLs = 3,868,275 ft^3
- Lead in groundwater exceeding NADCs = 20,085 ft^3

The volume of each area of impacted groundwater was then converted to gallons (gal) using the following equation:

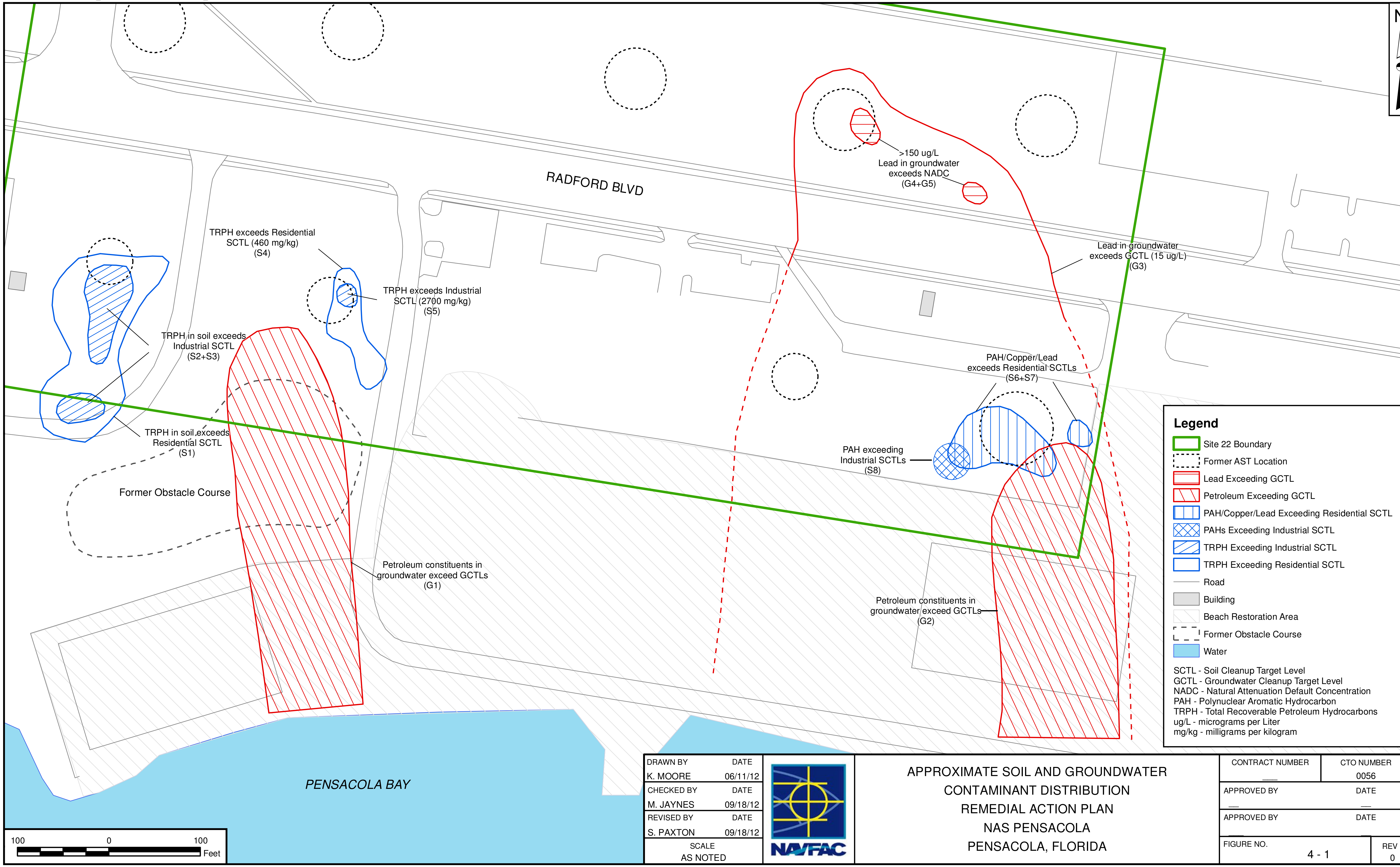
$$\text{Volume (gal)} = \text{Volume ft}^3 \text{ x } \frac{7.48 \text{ gal}}{1 \text{ ft}^3} \text{ x n}$$

n = porosity (15%)

The respective volumes for the three categories of groundwater are as follows:

- Petroleum constituents in groundwater exceeding GCTLs = 1,419,324 gals
- Lead in groundwater exceeding GCTLs = 4,340,205 gals
- Lead in groundwater exceeding NADCs = 22,535 gals

PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE21_PLUMES.MXD 9/18/2012 SP



5.0 REMEDIAL DESIGN/EVALUATION

The remedial alternatives presented in this RAP were selected based on feasibility, implementability, and costs for the mitigation of PAHs, TRPH, copper and lead in soil, and manganese, lead and TRPH in groundwater at UST Site 22. The remedial alternatives were identified, screened, and selected based on current site conditions and existing site features in an attempt to integrate them into an effective remedial action for the Site.

As discussed previously, the objectives of this RAP are as follows:

- Conduct a soil excavation to address PAHs in soil (above the water table) exceeding Florida industrial direct exposure SCTLs at Site 22.
- To evaluate and determine the integrity and effectiveness of the seawall at Site 22 as an engineering control for containment of lead in groundwater at the Site and keeping it from impacting the marine surface waters of Pensacola Bay.
- To assess MNA as a viable remedial option to address TRPH in groundwater at Site 22.

Supporting information for the remedial design/evaluation is provided in the following appendices: Appendix A contains contaminant mass and volume calculations; Appendix B contains the remedial alternative cost estimate, Appendix C contains the environmental footprint evaluation and Appendix D contains the RAP summary sheet and checklist.

5.1 SOIL EXCAVATION

The following subsections describe the assessment activities and details of the soil excavation to be conducted near the southeastern edge of Site 22 near the former AST. The proposed area of excavation is presented in Figure 5-1.

Soil will be excavated from an area of approximately 1,256 square feet (ft^2) to a depth of approximately 3 feet bls, which is above the water table, for a total volume of approximately 140 cubic yards (yd^3) of soil. As mentioned previously, PAHs exceeding Florida industrial direct exposure SCTLs are the basis for calculating the proposed soil volumes and the corresponding excavation limits. The final excavation limits will be determined based on additional sampling conducted prior to or during the excavation activities.

Because contamination will be left on-site at levels that preclude unlimited use and unrestricted exposure, implementation of land use controls (LUCs) will be required. LUCs will be implemented to limit use of the property, prohibit soil disturbance unless authorized by the Navy with the concurrence of FDEP and prohibit use of groundwater. The LUCs will be protective of human health by reducing the risk from the direct exposure to soil and groundwater. LUC details are described in Section 5.1.3.

5.1.1 Additional Assessment

As part of implementing the soil excavation at Site 22, additional assessment activities will be conducted around the proposed excavation area to confirm and, if possible, minimize the excavation boundaries. The additional soil assessment activities will be conducted during the "Baseline" groundwater sampling event described in Section 5.2. Previous information will form the basis for the selection of pre-excavation sampling locations for this investigation. However, gathering updated information to confirm the excavation boundaries prior to beginning the excavation will minimize the need to stage excavated soil, and also the logistics involved with delaying an ongoing excavation while waiting for confirmation analytical results for soil samples that could be obtained during the excavation activities.

The additional assessment activities should include the following:

- Conducting additional soil borings in the vicinity of soil sample location SB29 which contained soil (above the water table) with PAH concentrations exceeding industrial direct exposure SCTLs. Figure 5-1 presents the proposed soil sampling locations.
- The soil samples should be collected via hand auger at 1-foot intervals to a depth of 4 feet bls or the water table at the time of collection.
- The soil samples should be analyzed for PAHs at a fixed-based laboratory. If concentrations of PAHs from the additional assessment activities exceed Florida industrial direct exposure SCTLs, then the extent of excavation will be increased horizontally or vertically to include that area. Conversely, the data can be used to decrease the size of the excavation from that proposed in Section 4.0 if the data show PAH concentrations are less than their Florida industrial direct exposure SCTLs.

5.1.2 Excavation

This RAP specifies that soil will be excavated from a total area of approximately 1,256 ft^2. Based on the conclusions of the site assessments for Site 22, PAH concentrations in surface soil samples (0-2 feet bls) exceeded Florida industrial direct exposure SCTLs. Therefore, because the cleanup goals for soil (Table 3-1) are to meet the Florida industrial direct exposure SCTL for PAHs, the area (S8) indicated on Figure 5-1 will be excavated to at least 3 feet bls. However, the final excavation limits will be determined based on additional sampling conducted prior to initiation of the excavation activities (described above) and/or confirmatory sampling on the sidewalls and bottom of excavated areas. The components of the excavation portion of the remedy are described in detail below.

Utility clearance will be conducted in the proposed area of excavation and include, at a minimum, water, sewer, communication, and electrical lines. Following the utility clearance, excavation will occur at Area S8 (as described above) for a total volume of approximately 140 (in-situ) yd^3 of soil (Figure 5-1). Dust control measures and appropriate health and safety measures will be implemented during the excavation and screening.

The estimated volume of contaminated soil to be excavated is a consolidated, in-place volume. It is anticipated that the volume will increase 10 to 20 percent after the soils are excavated and are in an unconsolidated state. The excavated soil (140 yd^3) will be disposed of at an appropriate landfill based on its waste characterization that will be conducted in accordance with the Resource Conservation and Recovery Act (RCRA). Following excavation activities, confirmatory samples will be collected from the sidewalls and bottoms of the excavated areas to verify that Florida industrial direct exposure SCTLs are met.

The void left from the removal of approximately 140 yd^3 of excavated soil will be filled with clean backfill, and most likely sand at the surface to match the current beach restoration area in place at the Site. Full-suite laboratory analysis (volatile organics, semivolatile organics, pesticides, polychlorinated biphenyls, and priority pollutant metals will be conducted on a sample of the backfill to ensure it meets the Florida criteria for clean fill.

In summary, the excavation component of the selected remedy will consist of the following activities:

- Excavate an estimated 140 yd^3 of contaminated soil from Area S8 (Figure 5-1)
- Dispose of contaminated soil off-site based on waste characterization
- Backfill, compact, and regrade excavated areas to an elevation level to the existing land surface. The physical characteristics of the fill material should be similar to the existing native soil and beach restoration currently in place at Site 22
- Backfill will comply with Florida guidance for clean fill material

Refer to Appendix A for excavation calculations.

The excavated soil will be tested in accordance with RCRA regulations for waste characteristics using the Toxicity Characteristic Leaching Procedure (TCLP). Soil samples will be collected for TCLP analysis, which will be used to determine whether the soil is considered hazardous waste that requires treatment prior to disposal. For costing purposes, it is assumed that the COCs in the soil will not exceed TCLP limits and will not require treatment to meet land disposal requirements at a RCRA Subtitle D facility.

5.1.3 Land Use Controls

Because contamination will be left on site at levels that precludes unlimited use and unrestricted exposure, implementation of LUCs will be required. LUCs will be implemented within the Site 22 boundaries (see Figure 5-2) to prevent exposure to, or use of, contaminated soil and groundwater at the site; restrict the Site to non-residential use only; prohibit any excavation or other disturbances of existing areas or removal of contaminated surface and/or subsurface soils or any groundwater use at the Site unless prior written approval is obtained from the Navy with the concurrence of FDEP. The LUCs will preclude unacceptable human health risks from direct exposure to contaminated soil and groundwater. Specifically the LUCs would:

- Prohibit future use or reuse of the Site for residential or residential-like land uses unless prior written approval is obtained from the FDEP. Residential and residential-like land use restrictions prohibit uses including, but not limited to, any form of housing, any kind of school (including pre-schools, elementary schools, and secondary schools), child care facilities, playgrounds, and adult convalescent or nursing care facilities.

- Prohibit any excavation or other disturbances of contaminated subsurface soils exceeding residential SCTLs at the Site unless prior written approval is obtained from the FDEP.

- Prohibit all uses of groundwater from the surficial aquifer underlying the Site including, but not limited to, human consumption, dewatering, irrigation, heating/cooling purposes, and industrial processes unless prior written approval is obtained from the FDEP.

- Maintain the integrity of all existing or future monitoring and on-site remedy components at the Site.

The LUCs will be maintained until concentrations of the COCs in soil and groundwater are at levels that allow for unlimited use and unrestricted exposure. Although excavation and LUC development and implementation will be completed in less than 1 year, LUCs will remain in-place until risks associated with contaminated soil left in-place are reduced to acceptable levels. LUCs for groundwater will remain in-place until COCs are at levels that allow for unlimited use and unrestricted exposure.

LUCs were selected as a remedy to prevent human exposure to soil and groundwater at Site 22. The Navy is responsible for implementing, maintaining, reporting on, and enforcing LUCs. A supplemental LUC Implementation Plan (LUCIP) will be developed after the implementation of the additional assessment activities and proposed remedial activities to incorporate the appropriate areas where soil and groundwater exceed their respective SCTLs and GCTLs to satisfy the LUC component of the remedy for Site 22. This document will present periodic annual site inspection and maintenance requirements to ensure the LUCs are properly implemented.

5.2 ENGINEERING CONTROL EVALUATION - SEAWALL

The following subsections describe the assessment activities and monitoring that will be utilized to evaluate whether or not the seawall at the downgradient (or southern) edge of Site 22 is providing containment of lead contamination in groundwater, and keeping it from impacting the marine surface waters of Pensacola Bay. Pensacola Bay is a predominantly marine Class III water body and the seawall was recently (2009) repaired. The seawall adjacent to Pensacola Bay is constructed of a concrete barrier underlain by interlocked vertical steel sheet piling. The total barrier extends from the land surface to approximately 28 to 30 feet bls.

5.2.1 Additional Assessment

As part of the implementation of the RAP for Site 22, additional assessment activities will also be conducted to address FDEP's comments on the SARA III report. The additional assessment activities will be conducted as part of an initial "Baseline" evaluation/monitoring event and as specified hereafter. The additional assessment activities will include the following:

- Install additional onsite monitoring wells at the Site to aid in the seawall evaluation and for use in the MNA program (please refer to Section 6.0 Groundwater Monitoring Plan).

- Measure synoptic water levels at existing, replacement and new monitoring wells across the Site to determine groundwater flow.

- Collect additional groundwater samples from monitoring wells across the Site to "update" site data.

Additional monitoring wells will be installed at the southeastern corner of the Site near the seawall to delineate the extent of the lead contamination in groundwater and serve as evaluation wells for the engineering control evaluation for the seawall. Nine new monitoring wells, including three shallow or surficial monitoring wells, will be installed to a depth of approximately 15 feet bls to straddle the current water table and six deep monitoring wells will be installed to a depth of at least 30 feet bls to ensure they are installed below the maximum depth of the seawall. The deep wells will be used to determine if lead is migrating underneath the seawall into the marine surface waters of Pensacola Bay at concentrations that exceed Florida surface water quality criteria per Chapter 62-302, F.A.C.

Table 5-1 and Figure 5-2 present the proposed monitoring well locations that include existing, replacement, and new monitoring wells. Monitoring well construction details will be as follows:

- The newly installed monitoring wells will be constructed of new, polyvinyl chloride (PVC) well materials. Each monitoring well will be constructed with 1.5-inch inside diameter (ID) schedule 40 PVC well screen and riser.

- The shallow monitoring wells will have a screen interval of 10 feet with factory machined 0.010 inch slots and the deep monitoring wells will have a screen interval of 5 feet with factory machined 0.010 inch slots.

- Each monitoring well screen will be pre-packed with 20/30-grade silica sand to prevent the passage of formation sediments into the well screen.

- A surface seal of bentonite pellets and fine sand will be placed above the well screen in each monitoring well and each boring will be grouted to land surface to prevent the well from being a conduit for contaminants.

- The newly installed monitoring wells will be finished at land surface with a flush mount 8-inch diameter protective steel manhole cover.

Because of the nature of the lead exceedances, the monitoring well locations to be sampled during the assessment activities to evaluate the seawall and collect baseline data will include on-site monitoring well locations that have previously had exceedances of the Florida GCTL for lead per Chapter 62-550, F.A.C., and all newly installed monitoring wells (Table 5-1 and Figure 5-2). The monitoring wells to be sampled include existing wells, replacement wells, and new shallow and deep monitoring wells. The existing monitoring wells include: MW01, MW04, MW08, MW12, MW15, MW21, MW23, MW36, and MW41. The monitoring wells that no longer exist and will be replaced include: MW11R, MW13R, MW16R, MW17R, MW18R, MW19R, MW20R, MW24R, MW43R, MW53R, MW67R, MW68R, MW69R, MW71R, MW72R, MW73R, MW74R and MW76R. New shallow monitoring wells include: MW77, MW78, and MW79. New deep monitoring wells include: DMW69, DMW71, DMW72, DMW77, DMW78, and DMW79. The monitoring well locations selected for the additional assessment activities should provide an adequate representation of lead concentrations in groundwater across the Site. The groundwater samples will be analyzed using USEPA Method 6010 for lead.

Information obtained from the baseline event and all subsequent events will be used to evaluate whether or not the seawall is preventing lead from discharging into Pensacola Bay at concentrations that exceed its Florida surface water quality criteria. The baseline data will also be used to assess potential remedial progress during subsequent monitoring events.

5.2.2 Quarterly Groundwater Monitoring

Assessment of lead-impacted groundwater at Site 22 will include collecting additional groundwater samples and measuring synoptic water levels from existing, replacement, and new monitoring well locations on a quarterly basis (Table 5-1 and Figure 5-2). To evaluate site conditions and fully determine if the seawall is an effective engineering control for the Site, groundwater monitoring will need to be conducted for a minimum of one year. After the completion of one year of monitoring, then seawall monitoring program monitoring well locations will be reevaluated and combined with the monitoring program described in Section 6.0 Groundwater Monitoring Plan.

The monitoring wells designated to be measured and sampled on a quarterly basis for the seawall evaluation include: MW68R, MW69R, DMW69, MW71R, DMW71, MW72R, DMW72, MW73R, MW74R, MW75R, MW77, DMW77, MW78, DMW78, MW79 and DMW79 (Figure 5-2). The groundwater samples will be analyzed using United States Environmental Protection Agency (USEPA) Method 6010 for lead.

The DTW measurements from the selected wells will be used to determine groundwater flow and will be combined with the Baseline groundwater monitoring results for use in a groundwater model. The groundwater model will be used to determine if lead-impacted groundwater is being discharged to Pensacola Bay, and in turn will determine if the existing seawall is an effective engineering control (as containment) for the lead in groundwater per Florida Remedial Management Option (RMO) Level II (b).

Capital costs and operation and maintenance (O&M) (in this case monitoring) costs of the evaluation would be relatively low. Details of the proposed evaluation monitoring plan are presented in Section 6.0 of this RAP and the detailed cost estimate in provided in Appendix B.

5.3 SEAWALL MONITORING STATUS REPORTS

The implementation of the seawall monitoring plan should include three quarterly status reports for the first three quarterly monitoring events. The quarterly status reports will summarize the monitoring activities and shall contain the following information:

- Monitoring event date
- DTW measurements and potentiometric surface maps
- Groundwater analytical data
- Comparison of the groundwater analytical data to the RAP Goals in Section 3.0

- Evaluation of the effectiveness of the seawall and recommendations for further monitoring and evaluation

5.4 SEAWALL EVALUATION COMPLETION

The fourth and final report will be an annual report and will include the fourth quarter data and information from the three Seawall Status reports as described above. The annual report will provide an evaluation of the seawall as an engineering control (containment) for lead in groundwater for the four quarterly monitoring events. The annual report will evaluate and determine if the seawall monitoring can be optimized and included with the monitoring program described in Section 6.0. Also, if at the end of one year of monitoring, a definite decision cannot be made about the effectiveness of the seawall to contain the lead impacted groundwater, then additional remedial alternatives may need to be evaluated and recommended modifications will be discussed at that time. Based on the results of the quarterly seawall monitoring program, a RAP Modification or Addendum, may be completed and include recommendations on how to address the remaining concentrations of lead in groundwater at UST Site 22.

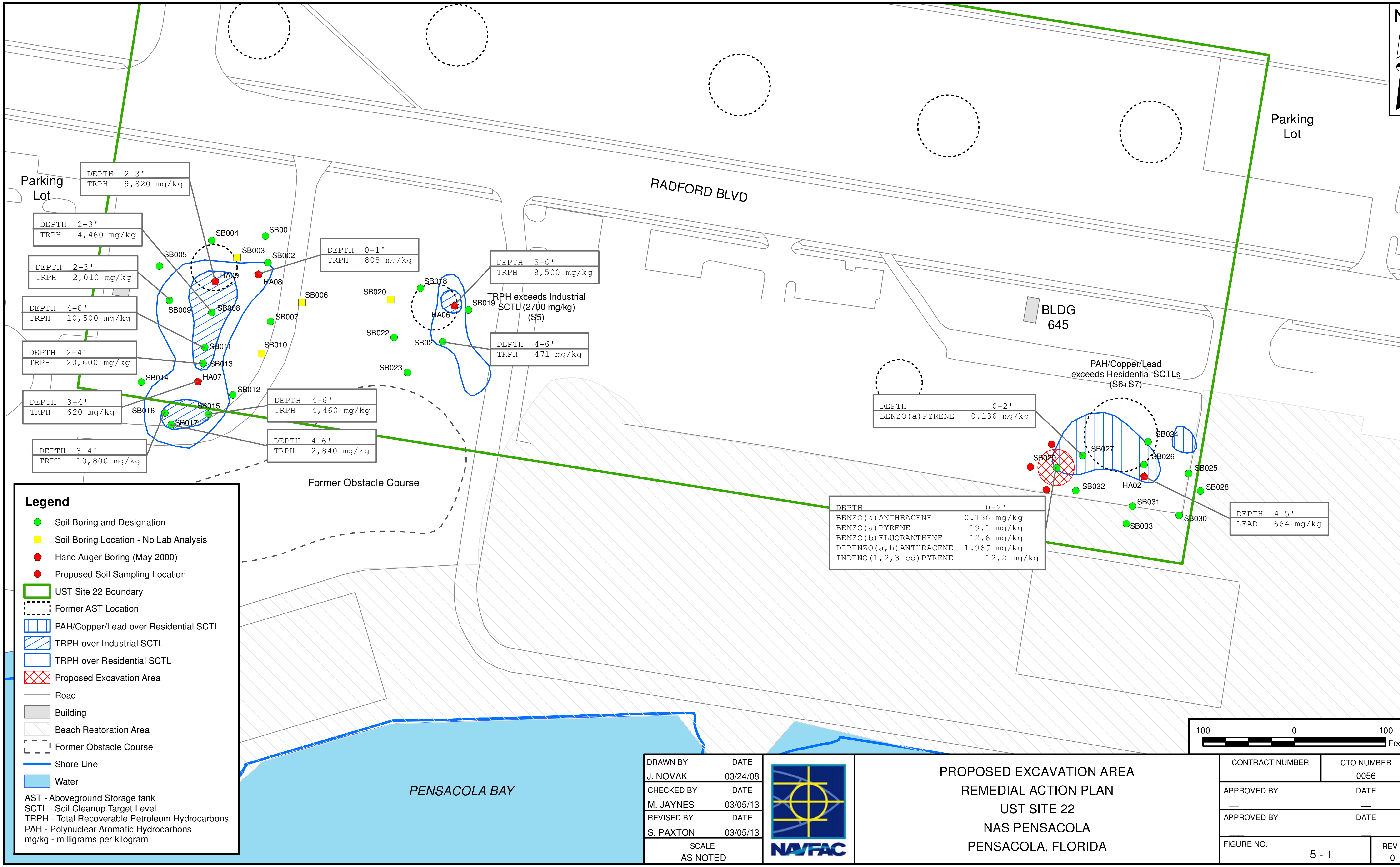
TABLE 5-1

**WELL LOCATIONS FOR SEAWALL ASSESSMENT AND MONITORING
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA**

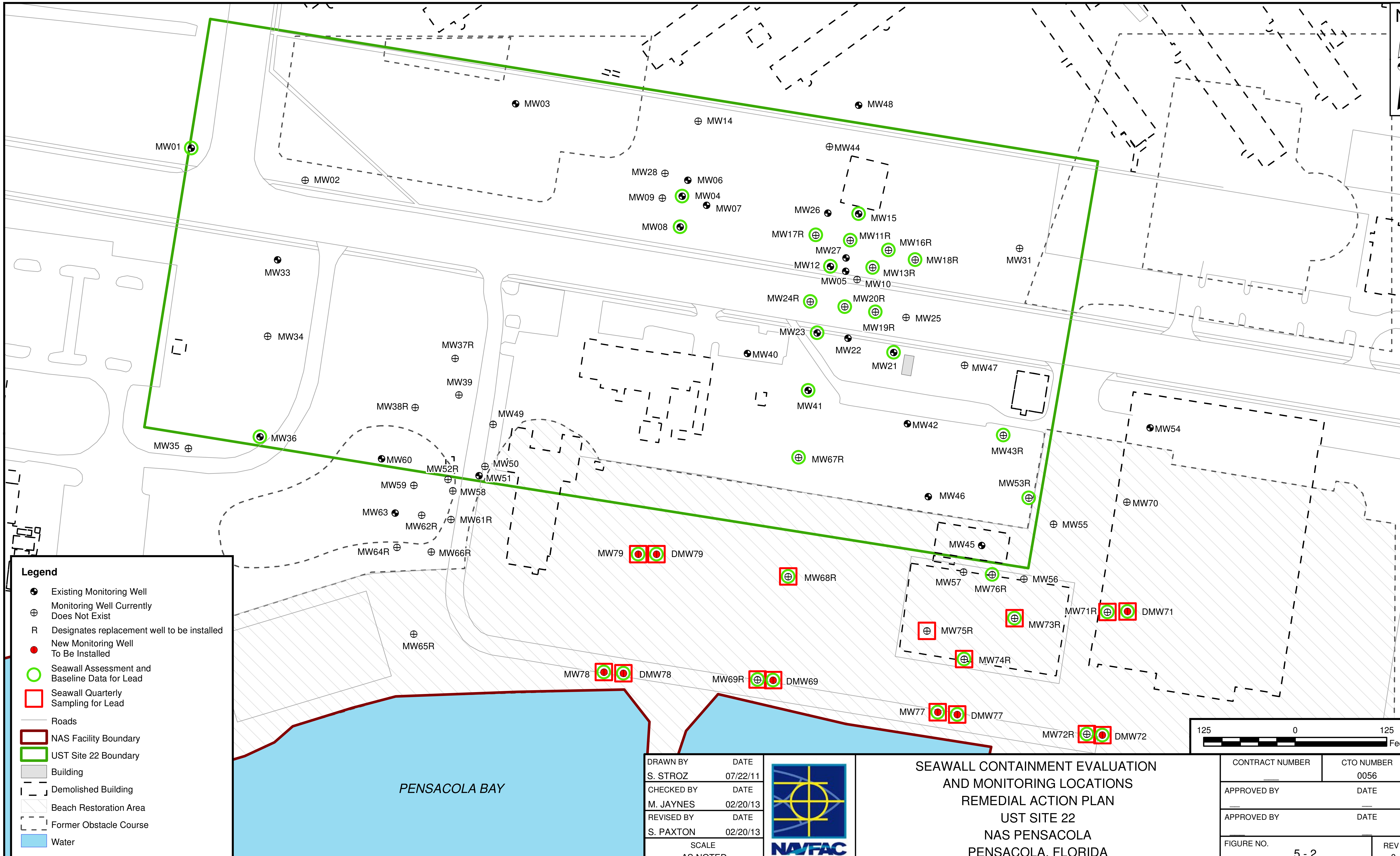
Location		Lead	Field Test						Sampling Frequency	Rationale
			pH	Temperature	Dissolved Oxygen	REDOX Potential	Conductivity	Turbidity		
Seawall Assessment - Lead	MW01	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW04	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW08	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW11R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW12	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW13R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW15	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW16R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW17R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW18R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW19R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW20R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW21	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW23	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW24R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW36	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW41	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Existing Well
	MW43R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW53R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW67R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW68R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW69R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW71R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW72R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW73R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW74R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW76R	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - Replacement Well
	MW77	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	MW78	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	MW79	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	DMW69	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	DMW71	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	DMW72	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	DMW77	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	DMW78	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
	DMW79	✔	✔	✔	✔	✔	✔	✔	Baseline only	Lead Resampling - New Well
Seawall Quarterly Monitoring	MW68R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	MW69R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	DMW69	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	MW71R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	DMW71	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	MW72R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	DMW72	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	MW73R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	MW74R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	MW75R	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - Replacement well
	MW77	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	DMW77	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	MW78	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	DMW78	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	MW79	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well
	DMW79	✔	✔	✔	✔	✔	✔	✔	Quarterly Monitoring	Seawall Evaluation & Modeling - New Well

Notes:
REDOX - Oxidation-Reduction
✔ - Denotes selected analysis

PGH:P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22_RAP_SCTL_EXCEEDANCES.MXD 3/5/2013 SP



PGH P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22_SEAWALL_MW.MXD 02/20/13 SP



6.0 GROUNDWATER MONITORING PLAN

This section establishes procedures for implementation of the monitoring plan for evaluation of the engineering control (seawall/containment) and MNA as remedial options at UST Site 22. Groundwater monitoring details including location, type, and frequency of analysis for each event are provided in Table 6-1 and monitoring well locations are provided in Figure 6-1. Post-evaluation/monitoring reporting requirements to be completed after the proposed remedial action/monitoring schedule has been conducted are also presented.

6.1 MONITORING IMPLMENTATION

Upon final approval and acceptance of the RAP for Site 22 by FDEP, the groundwater monitoring plan (GMP) will be initiated to evaluate MNA as a means of addressing the petroleum-related constituents (mainly TRPH) impact on groundwater. Monitoring for manganese is not included because it was not detected at concentrations exceeding its GCTL.

The initial sampling event will be the baseline sampling event that will serve as a comparison to all subsequent monitoring events. During the baseline event, site-wide collection of DTW measurements from existing, replacement and new monitoring wells will be conducted prior to the groundwater sampling. Groundwater sampling will be conducted at all designated monitoring wells as per the approved RAP and this GMP. The initial sampling event will also include the analysis of MNA parameters to establish the baseline contaminant profiles and comparable MNA monitoring parameters for the entirety of the evaluation/monitoring period (at least one year).

6.2 DESIGNATION OF EVALUATION/MONITORING WELLS

A select number of monitoring wells have been designated to address the petroleum-related constituents (predominantly TRPH) in groundwater and evaluate MNA at the Site. The monitoring wells to be sampled for the baseline event and all subsequent quarterly monitoring events include existing wells, wells that no longer exist and new shallow monitoring wells (Table 6-1 and Figure 6-1). Table 6-1 includes monitoring well location, type of analyses, and sampling frequency information.

The existing monitoring wells located in the petroleum-related constituent impacted area to the west side of the site include: MW60 and MW63. The replacement monitoring wells located in the petroleum-related constituent impacted area to the west side of the site consists of: MW37R, MW38R, MW52R, MW61R, MW62R, MW64R, MW65R and MW66R.

The replacement monitoring wells in the petroleum-related constituent impacted area to the east side of the site include: MW53R, MW68R, MW69R, MW71R, MW72R, MW73R, MW74R, MW75R, and MW76R.

New monitoring wells in the petroleum-related constituent impacted area to the east side of the site include: MW77 and DMW77.

6.3 EVALUATION OF MNA

Because TRPH has not been detected in groundwater samples from the monitoring wells located next to the seawall, interpretation of the analytical data obtained during the assessments at Site 22 suggest that the TRPH plume and isolated occurrence of ethylbenzene, xylenes, 1-metyhlnaphthalene, 2-methylnaphthalene, and naphthalene is stable and could be treated through natural attenuation.

MNA would achieve reductions in the concentrations of TRPH and other COCs at Site 22 through natural processes. Migration of the COCs in groundwater has not been identified as a concern for downgradient receptors; however, the MNA monitoring program would provide adequate warning of the potential for such migration so that additional action may be taken, if appropriate.

Monitoring would not reduce the toxicity of COCs in the groundwater; however, potential reductions in concentrations could occur through natural attenuation.

Assessment of the TRPH-impacted portion of the Site will consist of collecting additional groundwater samples from compliance points between the petroleum source areas and the seawall. The designated monitoring wells to be sampled in the petroleum-related constituent impacted area to the west side of the site include: MW37R, MW52R, MW62R, MW65R, and MW66R. The designated monitoring wells to be sampled in the petroleum-related constituent impacted area to the east side of the site are MW53R, MW73R, MW74R, and MW77 (Table 6-1 and Figure 6-1). If, in the baseline sampling event, TRPH is detected in the monitoring well samples near the seawall, the same rationale for using the seawall as containment for lead could be applied to TRPH.

A groundwater monitoring program could be readily implemented at Site 22. Permits would be required for installation of the proposed new monitoring wells; however, other additional monitoring wells will not be necessary because there are an adequate number of existing monitoring wells present at preferred and strategic locations.

Capital costs and monitoring costs of MNA would be relatively low. Details of the proposed MNA plan are presented in Section 6.0 and the detailed cost estimate is provided in Appendix B.

6.4 MONITORING PLAN

The GMP will include measuring water levels and collecting groundwater samples for analysis at an off-site fixed base laboratory during the baseline event (Event 1), and during subsequent quarterly monitoring events.

The following activities will be conducted during each groundwater sampling event:

- DTW measurements in the designated existing, replacement, and new monitoring wells to determine seasonal groundwater flow characteristics. Measurements will be conducted using a standard water-level meter/probe.

- Quarterly sampling and laboratory analysis of groundwater samples from the selected existing, replacement and new monitoring wells to document the concentrations of the targeted analytes and viability of MNA for a 1-year implementation/monitoring period. The groundwater samples will be analyzed using USEPA Method 8021 for Benzene, Toluene, Ethylbenzene and Xylene (BTEX), USEPA Method 8310 for PAHs, Florida Petroleum Range Organics (FL-PRO) for TRPH, and USEPA Method 6010 for lead as indicated in Table 6-1.

All groundwater samples will be collected using low-flow purging and sampling techniques per all applicable FDEP Standard Operating Procedures (SOPs) and guidelines.

The monitoring program will be evaluated in an Annual Monitoring Report after the first year and adjusted based on results of comparison of the quarterly data to the baseline event and cleanup target levels described in Section 3.0.

6.5 MONITORING OF REMEDIATION PROGRESS

The monitoring program data will be evaluated by determining groundwater flow directions and comparison of the analytical results to the RAP Goals provided in Section 3.0 after each sampling event. Evaluating the collected data after each sampling event should enhance the overall effectiveness of the monitoring program and the evaluation of MNA. If after the first year of monitoring, progress is not being made towards the RAP Goals in Section 3.0, then the evaluation/MNA monitoring may be discontinued, modified, and/or an alternate approach considered. The monitoring data will be used to determine if the objectives of the RAP are being met. Future modifications to the remedial action/monitoring plan will be based on the site-specific monitoring data.

6.6 QUARTERLY MONITORING PLAN STATUS REPORTS

The implementation of the MNA monitoring plan should include three quarterly status reports for the first three quarterly monitoring events. The quarterly status reports will summarize the monitoring activities and shall contain the following information:

- Monitoring event date

- DTW measurements and potentiometric surface maps
- Groundwater analytical data (including MNA parameters)
- Comparison of the groundwater analytical data to the RAP Goals in Section 3.0
- Conclusions/evaluation of the effectiveness of the MNA progress, and recommendations for further monitoring and evaluation

6.7 MONITORING PLAN EVALUATION COMPLETION

The fourth and final report will be an annual report that includes the fourth quarter data and information from the three Quarterly Monitoring Plan Status Reports as described above. The annual report will evaluate the viability of MNA to address the petroleum–related constituents (predominantly TRPH) in groundwater. If at the end of one year of monitoring, a definite decision cannot be made about the effectiveness of the MNA, then additional remedial alternatives may need to be evaluated and modifications will be discussed at that time. Based on the results of the monitoring program, a RAP Modification or Addendum, may be completed and include recommendations on how to address the remaining petroleum-related constituents in groundwater at UST Site 22.

6.8 ENVIRONMENTAL FOOTPRINT EVALUATION

An Environmental Footprint Evaluation is provided as an assessment of the sustainability of the remedial actions described in this RAP using the metrics of greenhouse gas (GHG) and criteria pollutant emissions, energy usage, and water consumption. The Environmental Footprint Evaluation is included as Appendix C.

TABLE 6-1

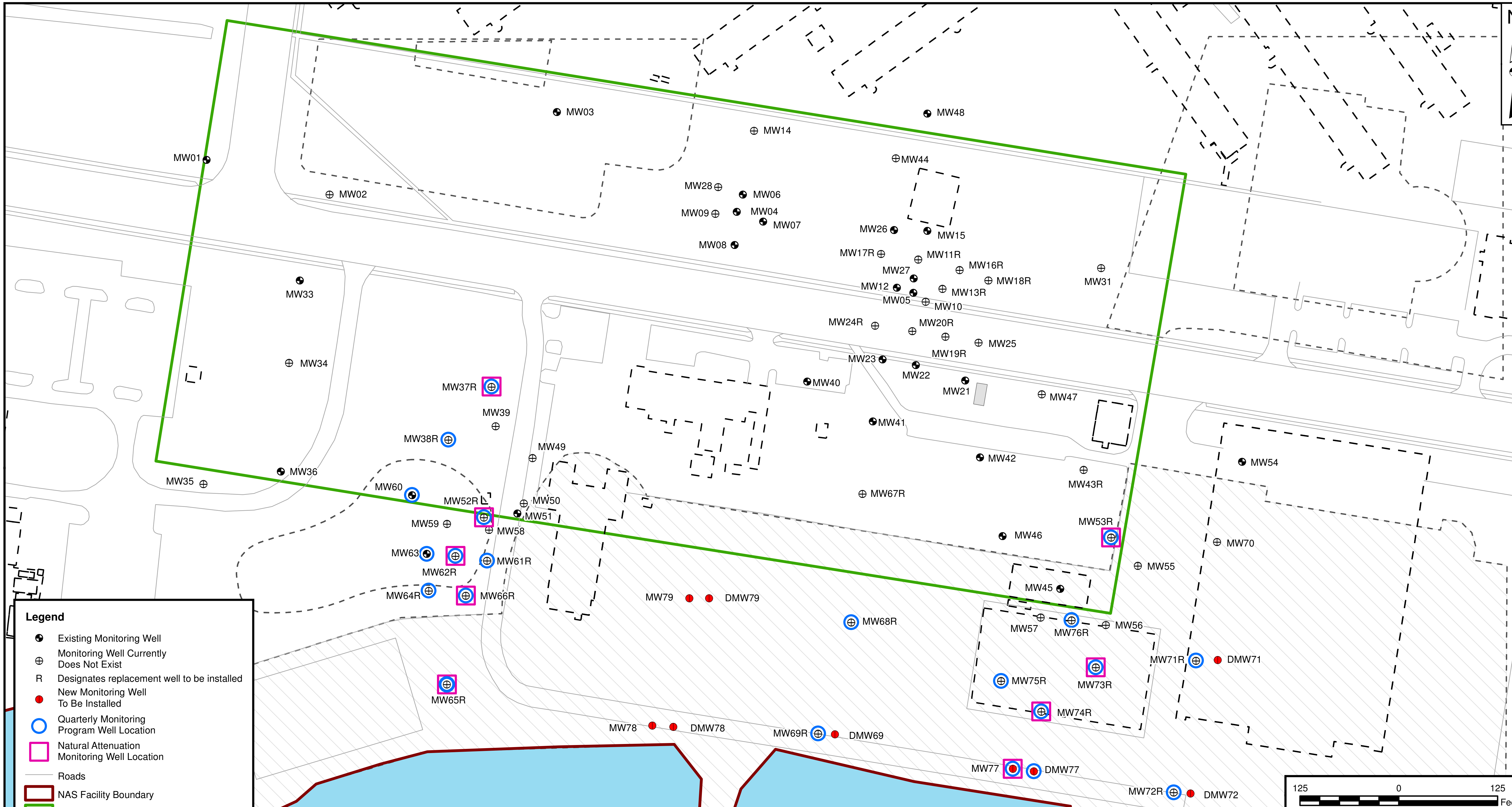
**WELL LOCATIONS FOR QUARTERLY MONITORING PROGRAM
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA**

Location		Laboratory Parameters				MNA Parameters					Field Test						Sampling Frequency	Well Status (Existing, Replacement or new)	Rationale
		BTEX	PAHs	TRPH	Lead	Nitrate-Nitrite	Sulfate-Sulfide	Ferrous Iron	Carbon Dioxide	Total Organic Carbon	pH	Temperature	Dissolved Oxygen	REDOX Potential	Conductivity	Turbidity			
Petroleum Impacted Area (West)	MW37R	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - upgradient compliance
	MW38R	✔	✔	✔							✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - source
	MW52R	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - source
	MW60	✔	✔	✔							✔	✔	✔	✔	✔	✔	Quarterly	Existing	Quarterly monitoring - source
	MW61R	✔	✔	✔							✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - source
	MW62R	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - source
	MW63	✔	✔	✔							✔	✔	✔	✔	✔	✔	Quarterly	Existing	Quarterly monitoring - source
	MW64R	✔	✔	✔							✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - source
	MW65R	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - source
	MW66R	✔	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - downgradient compliance
Petroleum Impacted Area (East)	MW53R	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - upgradient compliance
	MW68R	✔	✔	✔	x						✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - sidegradient
	MW69R	✔	✔	✔	x						✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - downgradient compliance
	MW71R	✔	✔	✔	x						✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - sidegradient
	MW72R	✔	✔	✔	x						✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - downgradient compliance
	MW73R	✔	✔	✔	x	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - source
	MW74R	✔	✔	✔	x	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - source
	MW75R	✔	✔	✔	x					✔	✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring - source
	MW76R	✔	✔	✔	✔						✔	✔	✔	✔	✔	✔	Quarterly	Replacement	Quarterly monitoring & MNA - source
	MW77	✔	✔	✔	x	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	Quarterly	New	Quarterly monitoring & MNA - downgradient compliance
	DMW77	✔	✔	✔	x						✔	✔	✔	✔	✔	✔	Quarterly	New	Quarterly monitoring - downgradient compliance

BTEX - Benzene, toluene, ethylbenzene, and xylenes (total)
PAHs - Polynuclear aromatic hydrocarbons
REDOX - Oxidation-Reduction
MNA - monitored natural attenuation
TRPH - Total recoverable petroleum hydrocarbons
✔ - Denotes selected analysis

x - Monitoring well is being sampled and analyzed for lead for 1 year under the Seawall Quarterly Monitoring Proram

PGH P:\GIS\PENSACOLA_NAS\MAPDOCS\MXD\SITE22_QTR_MONITORING.MXD 02/20/13 SP



DRAWN BY	DATE
S. STROZ	07/22/11
CHECKED BY	DATE
M. JAYNES	02/20/13
REVISED BY	DATE
S. PAXTON	02/20/13
SCALE	
AS NOTED	

NAVFAC

QUARTERLY MONITORING LOCATIONS
REMEDIAL ACTION PLAN
UST SITE 22
NAS PENSACOLA
PENSACOLA, FLORIDA

CONTRACT NUMBER	CTO NUMBER
	0056
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. 6 - 1	REV 0

REFERENCES

ATSDR (Agency for Toxic Substances and Disease Registry), 2006. Public Health Assessment for Naval Air Station Pensacola, Pensacola, Florida. March 14, 2006.

E & E (Ecology and Environmental), 1991. Phase I Installation Restoration Site Assessment for Site 21 Naval Air Station Pensacola, Pensacola Florida.

Florida Department of Environmental Protection (FDEP), 2005. Petroleum Contamination Site Cleanup Criteria, Chapter 62-770 Florida Administrative Code (F.A.C.). April.

FDEP, 2005. Development of Cleanup Target Levels (CTLs), Chapter 62-777, Florida Administrative Code, February.

Geraghty and Miller, Inc. 1986. Characterization Study, Assessment of Potential Ground-water Pollution at Naval Air Station, Pensacola, Florida.

NEESA (Naval Energy and Environmental Support Activity), 1983, Initial Assessment Study of Naval Air Station Pensacola. June.

Navy Public Works Center (PWC), 1997. Contamination Assessment Report (Site 21) Naval Air Station Pensacola, Pensacola, Florida, June.

Tetra Tech, Inc. (Tetra Tech), 2001. Site Assessment Report Addendum I for Underground Storage Tank Site 21/22 Naval Air Station Pensacola, Pensacola Florida, June.

Tetra Tech, 2002. Florida Regional Quality Assurance Manual, October 9, 2002.

Tetra Tech, 2003. Site Assessment Report Addendum II for Underground Storage Tank Site 22, Naval Air Station Pensacola, Pensacola Florida, April.

Tetra Tech, 2007. Corporate Standard Operating Procedures February 17, 2007.

Tetra Tech, 2012. Site Assessment Report Addendum III for Underground Storage Tank Site 22, Naval Air Station Pensacola, Pensacola Florida, January.

University of Florida, 2004. Technical Report: Development of Cleanup Target Levels (CTLs) for Chapter 62-777, F.A.C. Center for Environmental & Human Toxicology, Gainesville, Florida, February 26, 2004.

APPENDIX A

CONTAMINANT VOLUME AND MASS CALCULATIONS

Tetra Tech		SOIL VOLUME CALCUATION SHEET	
CLIENT: NAS PENSACOLA	FILE No: 112G00583	BY: MOJ	PAGE: 1 0F 1
SUBJECT: UST SITE 22 RAP	CHECKED BY: FKL	DATE: 06/01/12	

Objective: Estimate soil volumes for impacted soil areas exceeding **SCTLs** at Site 22.

Approach: Calculate soil volumes using most current data (SARA III) and depth information.

TRPH in soil exceeding Residential SCTLs:

LOCATION(S)	AREA x	DEPTH =	VOLUME	
	(ft^2)	(ft)	(ft^3)	(yd^3)
S1	16,431	4	65,724	2,434
S4	3,962	4	15,848	587

ESTIMATED TOTAL (ft^3) = 81,572
ESTIMATED TOTAL (yd^3) = 3,021
ESTIMATED TOTAL (Tons) = 4,230

TRPH in soil exceeding Industrial SCTLs:

LOCATION(S)	AREA x	DEPTH =	VOLUME	
	(ft^2)	(ft)	(ft^3)	(yd^3)
S2	1,330	4	5,320	197
S3	3,741	4	14,964	554
S5	449	4	1,796	67

ESTIMATED TOTAL (ft^3) = 22,080
ESTIMATED TOTAL (yd^3) = 818
ESTIMATED TOTAL (Tons) = 1,145

PAHs, Lead (and other Metals) in soil exceeding Residential SCTLs:

LOCATION(S)	AREA x	DEPTH =	VOLUME	
	(ft^2)	(ft)	(ft^3)	(yd^3)
S6	5,964	4	23,856	884
S7	586	4	2,344	87

ESTIMATED TOTAL (ft^3) = 26,200
ESTIMATED TOTAL (yd^3) = 970
ESTIMATED TOTAL (Tons) = 1,359

PAHs in soil exceeding Industrial SCTLs:

LOCATION(S)	AREA x	DEPTH =	VOLUME	
	(ft^2)	(ft)	(ft^3)	(yd^3)
S8	1,256	3	3,768	140

ESTIMATED TOTAL (ft^3) = 3,768
ESTIMATED TOTAL (yd^3) = 140
ESTIMATED TOTAL (Tons) = 195

Tetra Tech NUS		GROUNDWATER VOLUME CALCUATION SHEET	
CLIENT: NAS PENSACOLA	FILE No: 112G00583	BY: MOJ	PAGE: 1 0F 1
SUBJECT: UST SITE 22 RAP	CHECKED BY: FKL	DATE: 07/11/11	

Objective: Estimate volumes for impacted groundwater areas exceeding **GCTLs** at Site 22.

Approach: Calculate groundwater volumes using most recent data (SARA III) and information.

Petroleum-related constituents in groundwater exceeding GCTLs:

LOCATION(S)	AREA x (ft^2)	DEPTH x (ft)	POROSITY (0.15) = (ft^3)	VOLUME (gal)
G1	45,816	15	687,240	771,083
G2	38,517	15	577,755	648,241

ESTIMATED TOTAL (ft^3) = 1,264,995

ESTIMATED TOTAL (yd^3) = 46,852

ESTIMATED TOTAL (gallons) = 1,419,324

Lead in groundwater exceeding GCTLs:

LOCATION(S)	AREA x (ft^2)	DEPTH x (ft)	POROSITY (0.15) = (ft^3)	VOLUME (gal)
G3	257,885	15	3,868,275	4,340,205

ESTIMATED TOTAL (ft^3) = 3,868,275

ESTIMATED TOTAL (yd^3) = 143,269

ESTIMATED TOTAL (gallons) = 4,340,205

Lead in groundwater exceeding NADCs:

LOCATION(S)	AREA x (ft^2)	DEPTH x (ft)	POROSITY (0.15) = (ft^3)	VOLUME (gal)
G4	868	15	13,020	14,608
G5	471	15	7,065	7,927

ESTIMATED TOTAL (ft^3) = 20,085

ESTIMATED TOTAL (yd^3) = 744

ESTIMATED TOTAL (gallons) = 22,535

APPENDIX B

REMEDIAL ALTERNATIVE COST ESTIMATE

NAS PENSACOLA
Pensacola, Florida
Site 22
Remedial Action Plan - Excavation (only PAHs Industrial SCTL exceedances),, Seawall Evaluation, and MNA Groundwater Samplin
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
1 PROJECT PLANNING & DOCUMENTS											
1.1 Prepare Documents & Plans (RAP)	180	hr			$42.00		$0	$0	$7,560	$0	$7,560
1.2 Prepare Groundwater Monitoring Plan (Eval & MNA)	80	hr			$42.00		$0	$0	$3,360	$0	$3,360
1.3 Monitoring Reports (4/year, quarterly for 1 year)	160	hr			$42.00		$0	$0	$6,720	$0	$6,720
2 SITE SUPPORT FACILITIES INCLUDING MOB/DEMOB											
2.1 Office Trailer	0	mo				$375.00	$0	$0	$0	$0	$0
2.2 Field Office Support	0	mo		$150.00			$0	$0	$0	$0	$0
2.3 Storage Trailer (1)	0	mo				$101.00	$0	$0	$0	$0	$0
2.4 Utility Connection/Disconnection (phone/electric)	0	ls	$1,500.00				$0	$0	$0	$0	$0
2.5 Site Utilities	0	mo	$150.00				$0	$0	$0	$0	$0
2.6 Underground Utility Clearances	0	ls	$9,000.00				$0	$0	$0	$0	$0
2.7 Construction Survey Support	0	day	$935.00				$0	$0	$0	$0	$0
2.8 Field Construction Mgt. (1 person)	0	day		$193.00	$350.00		$0	$0	$0	$0	$0
3 WELL INSTALLATION											
3.1 Decon Pad	1	ea	$500.00				$500	$0	$0	$0	$500
3.2 DPT Mobilization/Demobilization	1	ea	$2,500.00				$2,500	$0	$0	$0	$2,500
3.3 Shallow Monitoring Well Installatio 1 1/2" diam., 30 wel	450	lf	$30.00				$13,500	$0	$0	$0	$13,500
3.4 Deep Monitoring Well Installation, 1 1/2" diam., 6 we lls	180	lf	$60.00				$10,800	$0	$0	$0	$10,800
3.5 Vault & Cover	36	ea	$200.00				$7,200	$0	$0	$0	$7,200
3.6 Well Development	34	hours	$750.00				$25,500	$0	$0	$0	$25,500
3.7 Collect/Containerize IDW	70	drum	$65.00				$4,550	$0	$0	$0	$4,550
3.8 Drum Staging	25	hours	$80.00				$2,000	$0	$0	$0	$2,000
3.9 Transport/Dispose IDW	70	drum	$185.00				$12,950	$0	$0	$0	$12,950
4 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$850.00	$500.00	$265.00	$0	$850	$500	$265	$1,615
3.2 Decon Water Disposal	5	drum	$125.00				$625	$0	$0	$0	$625
3.3 Decon Water Storage Drums	5	ea		$45.00			$0	$225	$0	$0	$225
3.4 PPE (2 p * 5 days * 1 Week)	10	m-day		$30.00			$0	$300	$0	$0	$300
3.5 Decontaminate Equipment (Pressure Washer)	5	ea			$134.45	$50.00	$0	$0	$672	$250	$922
5 SITE PREPARATION											
4.1 Erosion Control Fencing	200	lf		$0.23	$1.17		$0	$46	$234	$0	$280
4.2 Collect/Analyze Delineation Samples (cPAHs & others)	10	ea	$250.00	$10.00	$23.52		$2,500	$100	$235	$0	$2,835
4.3 Construction Surveys (2-man crew)	2	day	$850.00				$1,700	$0	$0	$0	$1,700
4.4 Utility Location and Site Delineation/Layout	1	ls	$1,500.00		$33.23		$1,500	$0	$33	$0	$1,533
4.5 Concrete Demolition/Removal (6" reinforced)	0	cy	$45.58				$0	$0	$0	$0	$0
4.6 Site Foreman/FOL	2	day			$300.00		$0	$0	$600	$0	$600
6 EXCAVATION/BACKFILL											
5.1 Excavate/Load Contaminated Soil (2.0 cy Hyd. Exc.)	5	day			$250.00	$1,200.00	$0	$0	$1,250	$6,000	$7,250
5.2 Standby, Crawler Mounted 2.0 CY Hydraulic Excavator	40	hrs				$37.54	$0	$0	$0	$1,502	$1,502
5.3 Wheel Loader, 3 cy	5	day			$250.00	$460.00	$0	$0	$1,250	$2,300	$3,550
5.4 Standby, Wheel Loader, 3 cy	20	hrs				$14.07	$0	$0	$0	$281	$281
5.5 Health & Safety Monitoring during Excavation	5	day			$188.16	$100.00	$0	$0	$941	$500	$1,441
5.6 Collect/Analyze Confirmatory Samples	5	ea	$250.00	$10.00	$23.52		$1,250	$50	$118	$0	$1,418
5.7 Import (Offsite) Place, Compact Clean Fill Material	140	cy		$13.00	$0.85	$1.81	$0	$1,820	$119	$253	$2,192
5.8 Backfill with Clean Excavated Material	0	cy		$0.28	$2.02	$0.76	$0	$0	$0	$0	$0
5.9 Site Foreman/FOL	6	day			$300.00		$0	$0	$1,800	$0	$1,800

NAS PENSACOLA
Pensacola, Florida
Site 22
Remedial Action Plan - Excavation (only PAHs Industrial SCTL exceedances),, Seawall Evaluation, and MNA Groundwater Samplin(
Capital Cost

Item	Quantity	Unit	Unit Cost Subcontract	Unit Cost Material	Unit Cost Labor	Unit Cost Equipment	Extended Cost Subcontract	Extended Cost Material	Extended Cost Labor	Extended Cost Equipment	Subtotal
7 OFF-SITE TRANSPORTATION/DISPOSAL											
6.1 Waste Profile	2	ls	$750.00				$1,500	$0	$0	$0	$1,500
6.2 Transport and Dispose of Soil (Non-haz.) in Landfill	196	ton	$55.00				$10,780	$0	$0	$0	$10,780
6.3 Prepare Shipment Manifests	20	hrs			$33.23		$0	$0	$665	$0	$665
8 EVAL and MNA (Event 1 - Baseline groundwater sampling)											
8.1 Senior Geologist/Engineer	2	day			$550.00		$0	$0	$1,100	$0	$1,100
8.2 GW samplers (2 persons)	5	day			$500.00		$0	$0	$2,500	$0	$2,500
8.3 Sampling (Lab, Material, Equipment)	1	ls	$10,000.00	$450.00		$1,850.00	$10,000	$450	$0	$1,850	$12,300
9 EVAL and MNA (Event 2 - Year 1)											
9.1 Senior Geologist/Engineer	0	day			$350.00		$0	$0	$0	$0	$0
9.2 GW samplers (2 persons)	3	day			$500.00		$0	$0	$1,500	$0	$1,500
9.3 Sampling (Lab, Material, Equipment)	1	ls	$8,500.00	$450.00		$1,850.00	$8,500	$450	$0	$1,850	$10,800
10 EVAL and MNA (Event 3 - Year 1)											
10.1 Senior Geologist/Engineer	0	day			$350.00		$0	$0	$0	$0	$0
10.2 GW samplers (2 persons)	3	day			$500.00		$0	$0	$1,500	$0	$1,500
10.3 Sampling (Lab, Material, Equipment)	1	ls	$8,500.00	$450.00		$1,850.00	$8,500	$450	$0	$1,850	$10,800
11 EVAL and MNA (Event 4-annual groundwater sampling - Year 1)											
11.1 Senior Geologist/Engineer	1	day			$550.00		$0	$0	$550	$0	$550
11.2 GW samplers (2 persons)	3	day			$500.00		$0	$0	$1,500	$0	$1,500
11.3 Sampling (Lab, Material, Equipment)	1	ls	$8,500.00	$750.00		$1,850.00	$8,500	$750	$0	$1,850	$11,100
12 MNA Sampling											
15.1 Senior Geologist/Engineer	0	day		$193.00	$350.00		$0	$0	$0	$0	$0
15.2 GW samplers (2 persons)	0	day			$210.00		$0	$0	$0	$0	$0
15.3 Sampling (Lab, Material, Equipment)	0	ls	$6,500.00	$850.00		$2,650.00	$0	$0	$0	$0	$0
13 SITE RESTORATION											
20.1 Top Dress Soil	0	cy	$30.00				$0	$0	$0	$0	$0
20.2 Site Restoration, beach	1,000	sf	$1.50				$1,500	$0	$0	$0	$1,500
Subtotal							$136,355	$5,491	$34,707	$18,751	$195,304
Overhead on Labor Cost @ 30%									$10,412		$10,412
G & A on Labor Cost @ 10%									$3,471		$3,471
G & A on Material Cost @ 10%								$549			$549
G & A on Equipment Cost @ 10%										$1,875	$1,875
G & A on Subcontract Cost @ 10%							$13,636				$13,636
Tax on Materials and Equipment Cost @ 6%								$329		$1,125	$1,455
Total Direct Cost							$149,991	$6,370	$48,589	$21,752	$226,701
Indirects on Total Direct Cost @ 18%											$40,806
Profit on Total Direct Cost @ 10%											$22,670
Total Field Cost											$290,177
Contingency on Total Field Costs @ 15%											$43,527
TOTAL CAPITAL COST											**$333,704**

APPENDIX C

ENVIRONMENTAL FOOTPRINT EVALUATION REPORT

APPENDIX C 1 ENVIRONMENTAL FOOTPRINT REPORT

ENVIRONMENTAL FOOTPRINT EVALUATION

FOR THE REMEDIAL ACTION PLAN

UNDERGROUND STORAGE TANK (UST) SITE 22

(INSTALATION RESTORATION SITE 21)

NAVAL AIR STATION (NAS) PENSACOLA

PENSACOLA, FLORIDA

JULY 2012

OBJECTIVE

This Environmental Footprint Evaluation of the excavation and monitoring stage for the scenario, previously described in Section 6 of the main text, is provided as an appendix to the Remedial Action Plan (RAP) for the Underground Storage Tank (UST) Site 22 located at Naval Air Station (NAS) Pensacola, in Pensacola, Florida. The purpose of the SRE is to assess the environmental impacts of the monitoring stage using metrics such as greenhouse gas (GHG) and criteria pollutant emissions, energy use, water consumption, and worker safety. The results of this SRE are intended to provide additional information for consideration during remedy selection and design and enhance the understanding of the environmental impacts throughout the remedy life-cycle for the activities related to the excavation and monitoring stage.

SUSTAINABILITY EVALUATION POLICY BACKGROUND

Department of Defense (DOD) and Navy policies require continual optimization of remedies in every phase from remedy selection through site closeout (NAVFAC, 2010a).

In January 2007, Executive Order 13423 set targets for sustainable practices for (i) energy efficiency, greenhouse gas emissions avoidance or reduction, and petroleum products use reduction, (ii) renewable energy, including bioenergy, (iii) water conservation, (iv) acquisition, (v) pollution and waste prevention and recycling, etc. In October 2009, Executive Order 13514 was issued, which reinforced these sustainability requirements and established specific goals for federal agencies to meet by 2020.

In August 2009 DOD issued a policy for “Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program.” The DOD policy and related Navy guidance state that opportunities to increase sustainability should be considered throughout all phases of remediation (i.e., site investigation, remedy selection, remedy design and construction, operation, monitoring, and site closeout). In response to this policy, the Department of the Navy (DON) issued an updated Navy Guidance for “Optimizing Remedy Evaluation, Selection, and Design” (NAVFAC, 2010), which includes environmental footprint evaluations as part of the traditional DON optimization review process for remedy selection, design, and remedial action operation. In August 2010, the Naval Facilities Engineering Command (NAVFAC) issued policy requiring use of the SiteWise™ tool to perform environmental impact reviews as part of all Feasibility Studies. As such, this environmental footprint evaluation of remedial alternatives is being performed to estimate the environmental footprint associated with each alternative in the interest of reducing the environmental impact of remedial action at NAS Pensacola Site 22.

Applying the DON optimization concepts with an environmental footprint evaluation within the remedy selection and design phases allows for the following benefits:

- Determining factors in each remedial alternative with the greatest environmental impacts and gathering insight into how to reduce these impacts;
- Evaluating remedial alternatives with optimized or reduced environmental footprints in conjunction with other selection criteria;
- Designing and implementing a more robust remedy while balancing the impact to the environment; and
- Ensuring efficient, cost-effective and sustainable site closeout.

EVALUATION TOOLS

This evaluation was performed using a hybrid model of the Navy’s SiteWise™ V2.0 tool supplemented with Tetra Tech’s GSRx model as appropriate for some site-specific items.

SiteWise™ is a life-cycle footprint assessment tool developed jointly by the U.S. Navy, U.S. Army Corps of Engineers (USACE), and Battelle. SiteWise™ assesses the environmental footprint of a remedial alternative/technology using a consistent set of metrics. The assessment is conducted using a building block approach, where each remedial alternative is first broken down into modules that follow the phases for most remedial actions, including remedial investigation (RI), remedial action construction (RAC), remedial action operation (RAO), and long-term monitoring (LTM). Once broken down by remedial phase, the footprint of each phase is calculated. The phase-specific footprints are then combined to estimate the overall footprint of the remedial alternative. This building block approach reduces redundancy in the footprint assessment and facilitates the identification of specific impact drivers that contribute to the environmental footprint. The inputs that need to be considered include (1) production of material required by the activity; (2) transportation of the required materials to the site, transportation of personnel; (3) all site activities to be performed; and (4) management of the waste produced by the activity.

GSRx (Green Sustainable Remediation Tool) builds off of SiteWise™ and allows for a flexible, detailed analysis, particularly for materials and equipment use. GSRx was used to account for materials and activities not readily input into SiteWise™ and where equipment usage assumptions built into SiteWise™ were not consistent with site-specific requirements.

ENVIRONMENTAL FOOTPRINT EVALUATION FRAMEWORK AND LIMITATIONS

The environmental footprint evaluation performed for Site 22 Pensacola NAS considered life-cycle quantitative metrics for global warming potential (through greenhouse gas emissions), criteria air pollutant emissions (through NO_X, SO_X and PM_{10} emissions), energy consumption, water usage, and worker safety.

Life cycle impacts were calculated for energy consumption, emissions of GHG (carbon dioxide [CO_2], methane [CH_4], and nitrous oxide [N_2O]) and criteria pollutants (nitrogen oxides [NO_x], sulfur oxides [SO_x] and particulate matter [PM_{10}]), water usage, and energy consumption, and worker safety.

Life cycle inventory inputs in SiteWise™ were divided into four categories – 1) materials production; 2) transportation of personnel, materials and equipment; 3) equipment use and miscellaneous; and 4) residual handling and disposal. Cost estimates from the RI/FS and design calculations were used as a basis for inventory quantities and related assumptions. Emission factors, energy consumption, and water usage data were correlated to material quantities, equipment, transportation distances, and installation time frames in order to calculate life-cycle emissions, energy consumption, water usage, and worker safety. Default SiteWise™ emission, energy usage, water consumption, and worker fatality and accident risk factors were utilized.

Although GSRx was used to minimize limitations resulting within SiteWise™, elimination of all limitations was not possible while using a hybrid model of SiteWise™ and GSRx. For example, several materials and construction equipment inventoried were input into GSRx and these impacts were incorporated into SiteWise™ within the “Equipment Use and Miscellaneous” sector. This sector in SiteWise™ does not differentiate into the specific equipment usage or material consumption items that are input in GSRx, but rather are considered miscellaneous items. However, impact drivers for items input in GSRx can be identified and evaluated directly within the respective GSRx evaluation and output summary sheets. In addition, worker safety results in general do not include worker safety related to equipment usage that was input within GSRx because GSRx was not developed to evaluate worker safety.

EVALUATION RESULTS

The following are the alternatives that were analyzed with SiteWise™ and GSRx for the RAP at NAS Pensacola Site 22:

- Excavation and Monitoring Natural Attenuation (MNA)

The following sections summarize the relative environmental impacts and primary impact drivers for the excavatopm and MNA Scenario and respective metrics. In addition, the supporting information includes the input (Appendix C-2) and output (Appendix C-3) sheets that were used for the SiteWise™/GSRx hybrid model. An evaluation of SiteWise™ and GSRx output summary sheets and related figures included in the Environmental Footprint Evaluation Appendix C-3 provides detailed information on the contribution to eac each phase of the remedial process and for each respective input category (materials production, transportation, equipment usage, etc). Further inspection of related inventory and SiteWise™ and GSRx input sheets (Appendix C-2) provide information on the specific contribution to a metric from each item of material, transportation, equipment, etc. This level of detail also helps clarify results that could be misinterpreted based on SiteWise™ data entry limitations mentioned previously.

Greenhouse Gas Emissions

Emissions of CO_2, CH_4, and N_2O were normalized to CO_2 equivalents (CO_2e), which is a cumulative method of weighing GHG emissions relative to global warming potential. Figure 1 is the graphical representation of the distribution of GHG emissions for the scenario evaluated. The x-axis shows the scenario evaluated and the y-axis is the amount of emissions in metric ton of CO_2e.

The total amount of GHG emissions resulting from the proposed scenario is 23.71 metric ton of CO_2e. The activity with the highest contribution to GHG emissions is the use of the laboratory analytical services. The laboratory analytical services releases 10.26 metric ton of CO_2e which it represents approximately 43.2 percent of the total GHG emissions. The activity with the second highest contribution to GHG emissions is the residual handling operations. Residual handling operations contributes with 4.05 metric ton of CO_2e, which it is approximately 17.1 percent of the total GHG emissions. The third highest contributor to GHG emissions is the use of the excavator during its 32 hours of operation. The excavator releases approximately 13 percent of the total GHG emissions, corresponding to 3.10 metric ton of CO_2e.

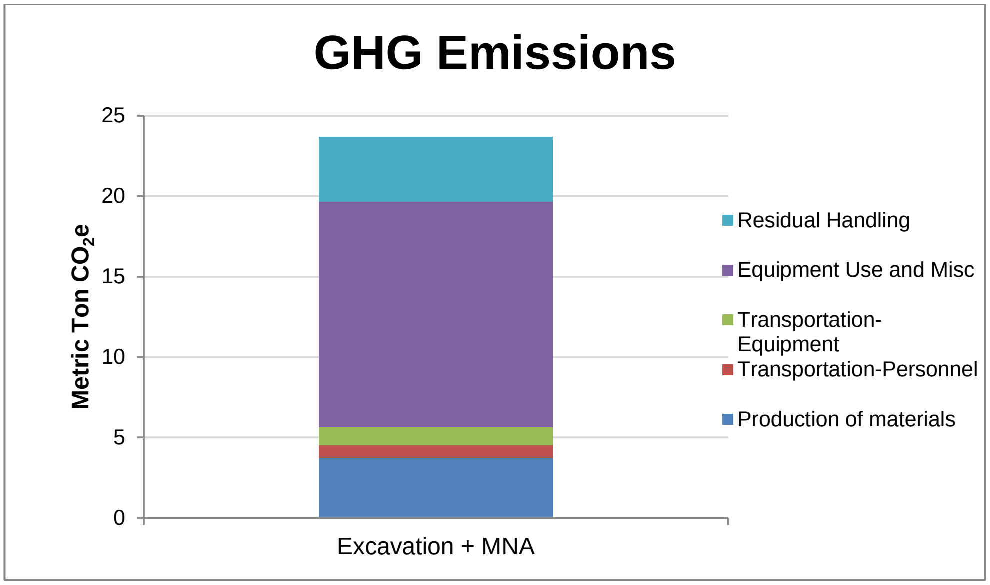


Figure 1 – GHG Emissions For Excavation and MNA Scenario at UST Site 22 Pensacola

Figure 2 shows the breakdown of the percent that each of main activities of each alternative (x-axis) contributes to the GHG emissions (y-axis).

The total amount of GHG emissions resulting from this scenario is 23.71 metric ton of CO_2e. The activity group with the highest contribution to these emissions is the equipment use and miscellaneous, where 14.03 metric ton of CO_2e are released to the atmosphere, corresponding to approximately 59.2 percent of the total GHG emissions. The activity sector with the second highest contribution to these emissions is the residual handling operations, where 4.05 metric ton of CO_2e are released, approximately 17 percent of the total GHG emissions. Production of materials emits 3.70 metric ton of CO_2e, corresponding to 15.6 percent of the total GHG emissions, making this activity group the third highest contributor to these emissions.

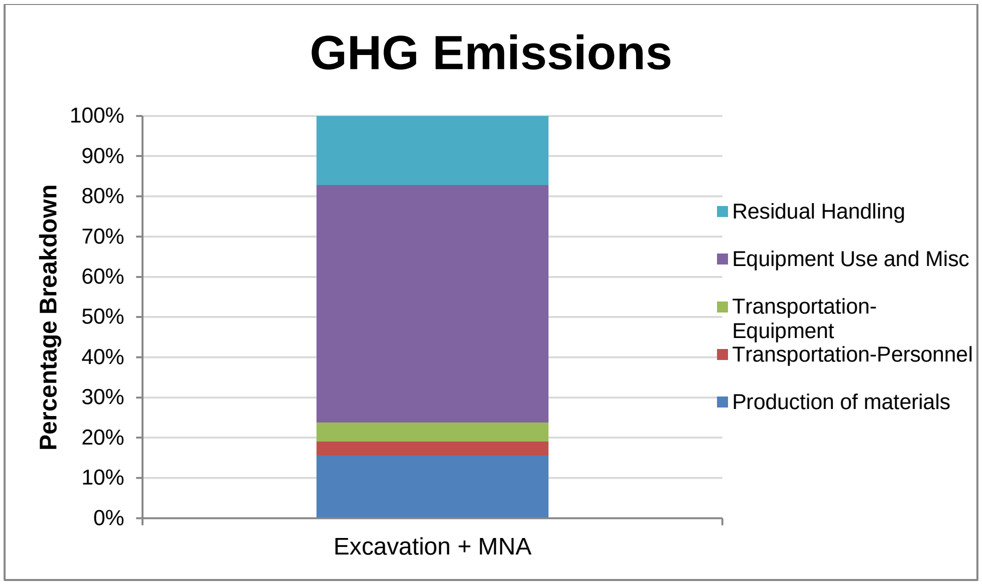


Figure 2 – GHG Emissions Percentage Breakdown For Excavation and MNA Scenario at UST Site 22 Pensacola

Criteria Pollutant Emissions

NO_X Emissions

Figure 3 shows the amount of NO_X emissions from the Scenario evaluated. The x-axis of this graph contains the scenario evaluated, and the y-axis represents the amount of NO_X emissions in metric ton.

The total amount of NO_X released by the Excavation and MNA scenario is $7.47x10^{-2}$ metric ton. The activity with the highest contribution to NO_X emissions is the laboratory analytical services. The amount of NOX released by this activity is $3.55x10^{-2}$ metric ton, which corresponds to approximately 47.5 percent of the total NO_X emissions for this scenario. The activity with the second highest contribution to these air emissions is the use of the excavator which is in operation for 32 hours. The amount of NO_X that is emitted is $1.95x10^{-2}$ metric ton, which corresponds to approximately 26.1 percent of the total NO_X emissions. Residual handling operations is the activity with the third highest contribution to NO_X emissions. The amount of NO_X resulting from this particular activity is $1.30x10^{-2}$ metric ton, which corresponds approximately to 17.4 percent of the total NO_X emissions.

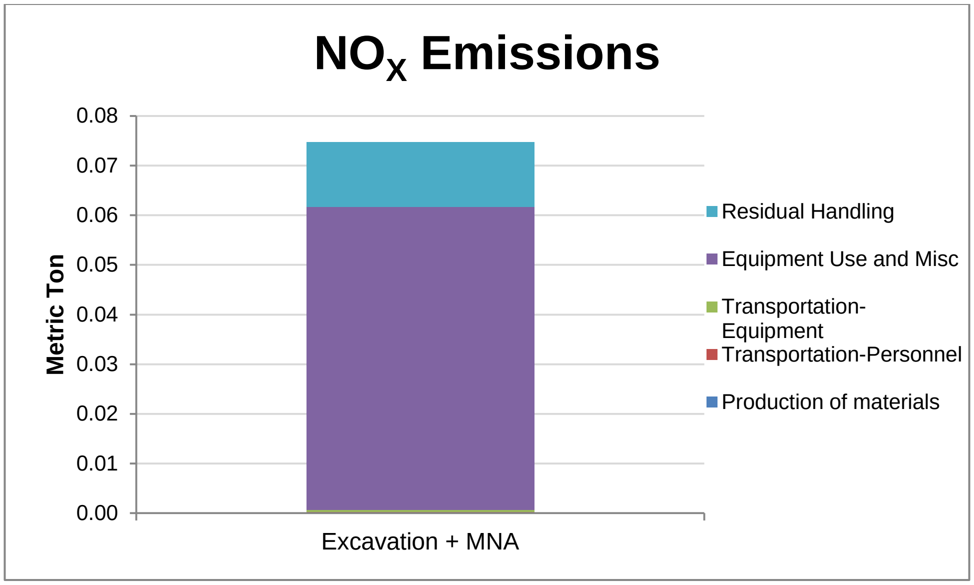


Figure 3 – NO_X Emissions For Excavation and MNA Scenario At UST Site 22 Pensacola

Figure 4 shows the percentage contribution from each of the main activity sectors.

The total amount of NO_X emissions for the Excavation and MNA scenario is 7.47×10^{-2} metric ton. The activity sector with the highest contribution to NO_X emissions is the equipment use and miscellaneous, where 6.1×10^{-2} metric ton of NO_X are released, corresponding to approximately 81.7 percent of the total NO_X emissions. Residual handling operations is the activity group with the second highest contribution to NO_X emissions, where approximately 17.4 percent of the total NO_X emissions are released as a result of these activities, corresponding to 1.3×10^{-2} metric ton of NO_X. The activity sector with the third highest contribution to these emissions is the transportation of equipment and materials, where 3.48×10^{-4} metric ton of NO_X are released, corresponding to approximately 0.5 percent of the total NO_X emissions for this scenario.

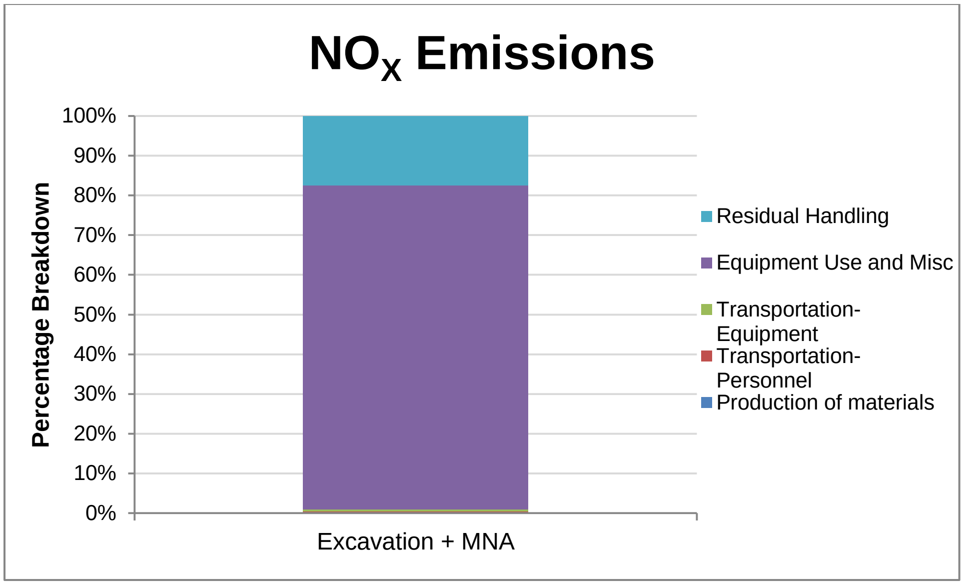


Figure 4 – NO_X Emissions Percentage Breakdown For Excavation and MNA Scenario at UST Site 22 Pensacola

SO_X Emissions

Figure 5 contains the distribution of the SO_X emissions resulting from the activities related to the Excavation and MNA Scenario. The x-axis of this graph represents the scenario evaluated; the y-axis represents the SO_X emissions in metric ton.

The total amount of SO_X emissions resulting from the Excavation and MNA Scenario is 4.10×10^{-2} metric ton of SO_X. The activity with the highest contribution to SO_X emissions is the laboratory analytical services. The laboratory analytical services emits 2.37×10^{-2} metric ton of SO_X, which corresponds to approximately 57.6 percent of the total SO_X emissions for this scenario. Residual handling operations is the activity with the second highest contribution to SO_X emissions. The amount of SO_X released to the atmosphere during the residual handling operations is 6.68×10^{-3} metric ton of SO_X, which corresponds to approximately 16.2 percent of the total SO_X emissions. The use of the excavator is the activity that has the third highest contribution to SO_X emissions. The excavator is used for 32 hours, the SOX emissions as a result of this equipment use are 5.75×10^{-3} metric ton of SO_X, which corresponds to approximately 14.0 percent of the total SO_X emissions.

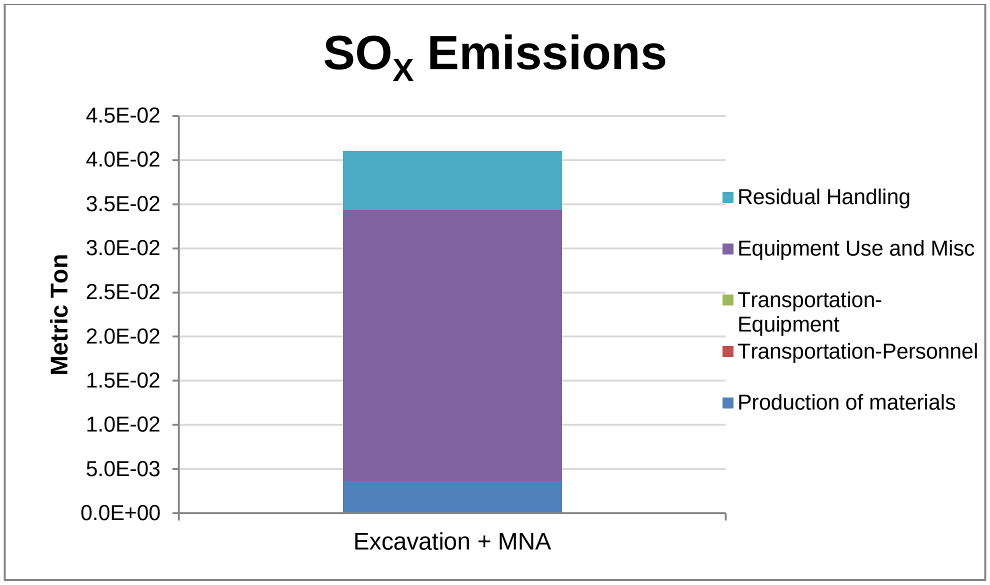


Figure 5 – SO_X Emissions For Monitoring Scenarios At UST Site 22 Pensacola

Figure 6 shows the percentage breakdown of the activities contributing to SO_X emissions.

The total amount of SO_X emissions for the Excavation and MNA scenario is $4.10x10^{-2}$ metric ton. The activity group with the highest contribution to SO_X emissions is the equipment use and miscellaneous, where $3.07x10^{-2}$ metric ton of SO_X are released, corresponding to approximately 74.8 percent of the total SO_X emissions for this scenario. Residual handling operations is the activity with the second highest contribution to SO_X emissions emitting $6.68x10^{-3}$ metric ton of SO_X, corresponding to approximately 16.3 percent of the total SO_X emissions. The activity sector with the third highest contribution to SO_X emission is the production of raw materials, where $3.66x10^{-3}$ metric ton of SO_X are released to the atmosphere, corresponding to approximately 8.9 percent of the total SO_X emissions resulting from the Excavation and MNA scenario.

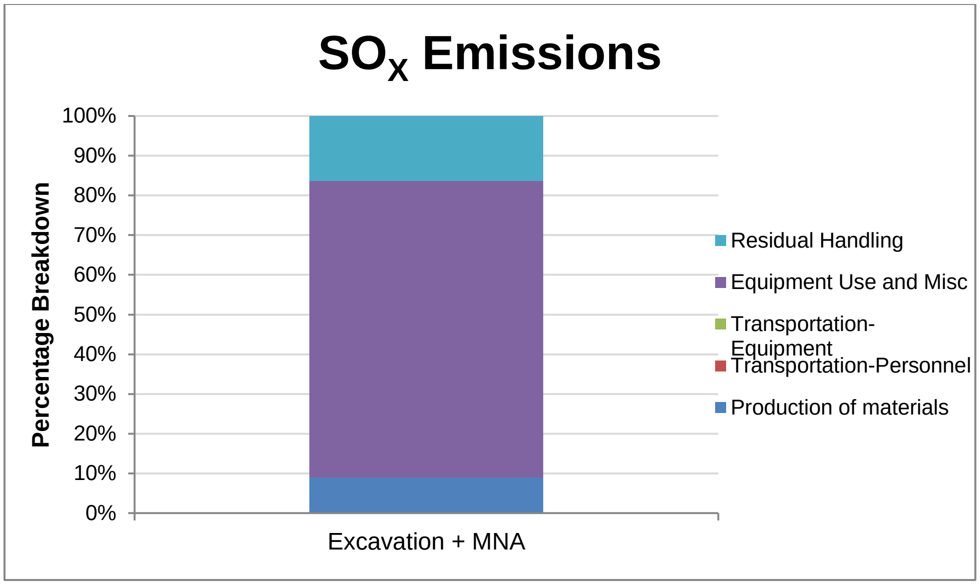


Figure 6 – SO_X Emissions Percentage Breakdown For Excavation and MNA Scenario at UST Site 22 Pensacola

PM_{10} Emissions

The breakdown of the distribution of the PM_{10} emissions resulting from the activities involved in the Excavation and MNA scenario are shown in Figure 7. The x-axis of this figure represents the scenario evaluated, while the y-axis represents the PM_{10} emissions in metric ton.

For the Excavation and MNA scenario the total amount of PM_{10} released to the atmosphere is 3.97×10^{-2} metric ton. The activity with the highest contribution to these emissions is the residual handling operations. The residual handling operations emitts 3.56×10^{-2} metric ton of PM_{10}, which corresponds to approximately 89.6 percent of the total PM_{10} emissions for this scenario. The use of the excavator is the activity with the second highest contribution to PM_{10} emissions. The excavator is in use during 32 hours, releasing 1.85×10^{-3} metric ton of PM_{10}, corresponding to approximately 4.67 percent of the total PM_{10}. The laboratory analytical services is the activity with the third highest contribution to these particular emissions. The amount of PM_{10} released by the laboratory analytical services is 9×10^{-4} metric ton, corresponding to approximately 2.26 percent of the total PM_{10} emissions.

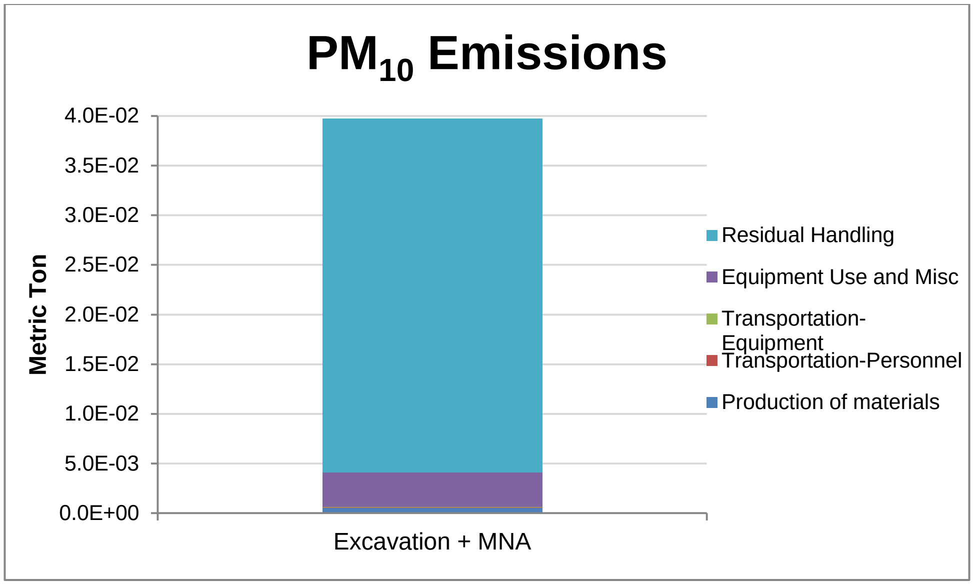


Figure 7 – PM_{10} Emissions For Monitoring Scenarios At UST Site 22 Pensacola

Figure 8 shows the percentage of PM_{10} emissions contributed by each of the activity sectors per alternative.

The total amount of PM_{10} released to the atmosphere due to the activities taking place during the Excavation and MNA scenario is $3.97\text{x}10^{-2}$ metric ton. Residual handling operations is the activity group with the highest contribution to PM_{10} emissions, where 89.6 percent of the total emissions (approximately $3.56\text{x}10^{-2}$ metric ton of PM_{10}) result from this activity sector. The activity with the second highest contribution to PM_{10} emissions is the equipment use and miscellaneous, where $3.51\text{x}10^{-3}$ metric ton of PM_{10} are released, corresponding to approximately 8.8 percent of the total PM_{10} emissions. The activity group with the third highest contributions is the production or materials, where $5.32\text{x}10^{-4}$ metric ton of PM_{10} are released to the atmosphere, corresponding to approximately 1.3 percent of the total PM_{10} emissions.

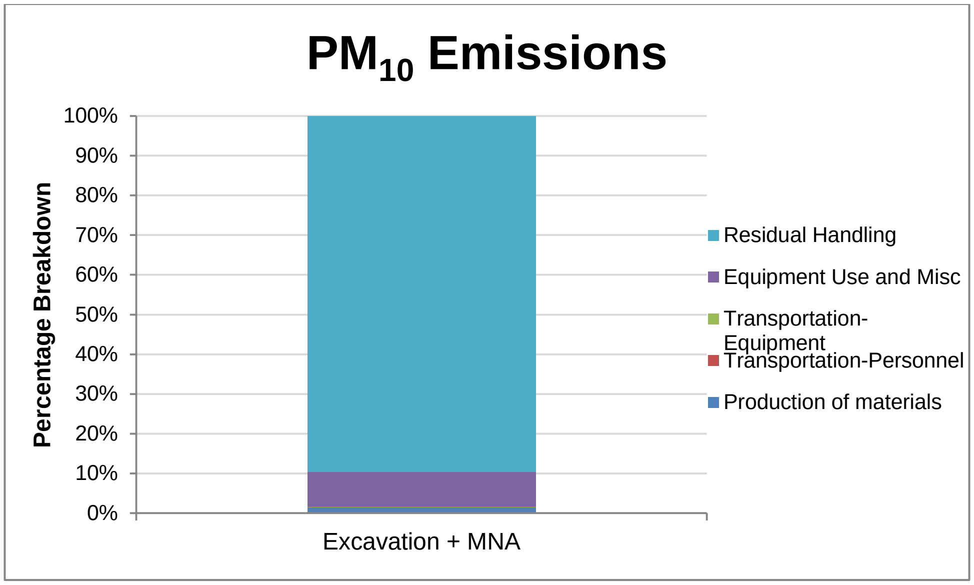


Figure 8 – PM_{10} Emissions Percentage Breakdown For Excavation and MNA Scenario at UST Site 22 Pensacola

Energy Consumption

The energy consumption for the scenario evaluated is shown in Figure 9. The x-axis shows the scenario evaluated, and the y-axis shows the amount of energy consumed in units of million British Thermal Units (MMBTU).

The total amount of energy used from the Excavation and MNA scenario is 525.16 MMBTU. The activity with the highest energy consumption is the production of borrow soil. The amount of borrow soil needed as backfill is 140 cubic yards (CY), and the energy needed to produce this soil is 175.56 MMBTU. The energy used during the production of borrow soil is approximately 33.48 percent of the total energy consumed by this scenario. Laboratory analytical services is the activity with the second highest energy consumption. Laboratory analytical services consumes 153.12 MMBTU, corresponding to 29.2 percent of the total energy used by the scenario. The activity with the third highest energy consumption is the residual handling operations. During the residual handling operations, the amount of energy used is 70.88 MMBTU, which corresponds to approximately 13.52 percent of the total energy consumption.

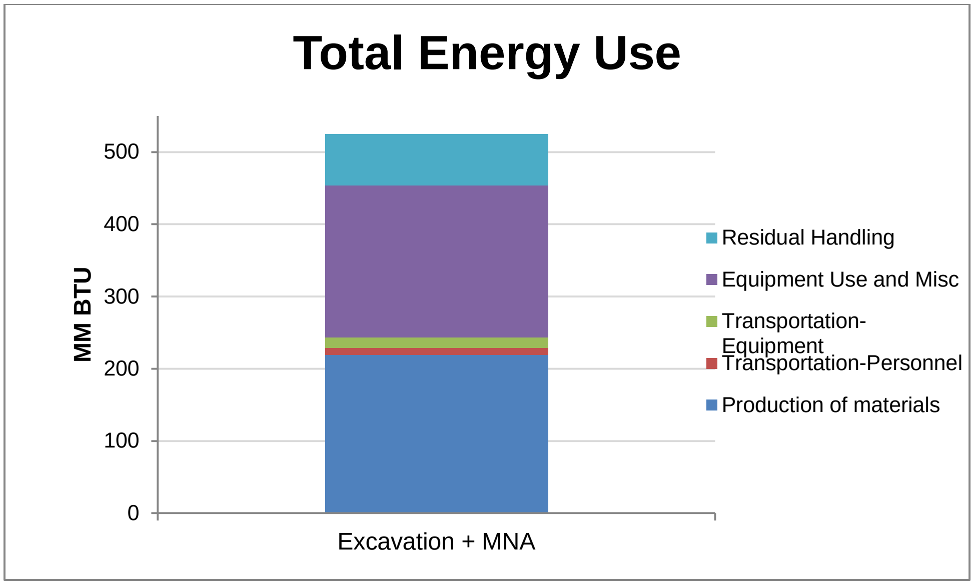


Figure 9 – Energy Consumption For Monitoring Scenarios At UST Site 22 Pensacola

Figure 10 shows the percentage breakdown contribution of energy consumption from the different activity groups.

The total amount of energy used during the Excavation and MNA scenario is 525.16 MMBTU. The activity group that consumes the most amount of energy is the production of materials, where 218.79 MBTU are consumed, approximately 41.7 percent of the total energy use for this scenario. Equipment use and miscellaneous sector consumes 210.74 MMBTU, corresponding to the second highest consumer of energy for this scenario, approximately 40.1 percent of the total energy use. The sector with the third highest consumption of energy is the residual handling operations, where 70.88 MMTBU are used, approximately 13.5 percent of the total energy consumption for this scenario.

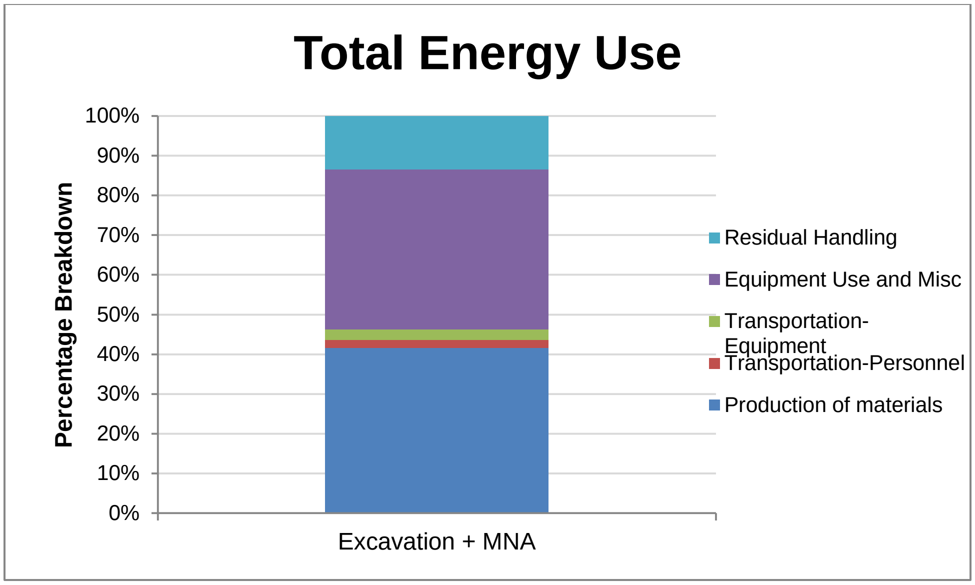


Figure 10 – Energy Consumption Percentage Breakdown For Excavation and MNA Scenario at UST Site 22 Pensacola

Water Consumption

The water consumption of the evaluated alternatives is shown in Figure 11. The x-axis shows the scenario evaluated and the y-axis show the amount of water consumed in gallons of water.

The total amount of water consumed by the Excavation and MNA Scenario is 553.9 gallons of water. The activity with the highest water consumption is the use of decontamination water, where 275 gallons of water are used for this process. The water consumption during the decontamination process corresponds to approximately 50 percent of the total water consumption by this scenario. The activity with the second highest consumption of water is the production of HDPE, where 263.7 gallons of water are consumed. The production of HDPE consumes approximately 47.6 percent of the total water usage of this scenario. The production of electricity (electricity used to power the pressure washer) is the activity with the third highest water consumption of 12.2 gallons of water. The use of the pressure washes corresponds to utilizing 2.2 percent of the total water consumption for this scenario.

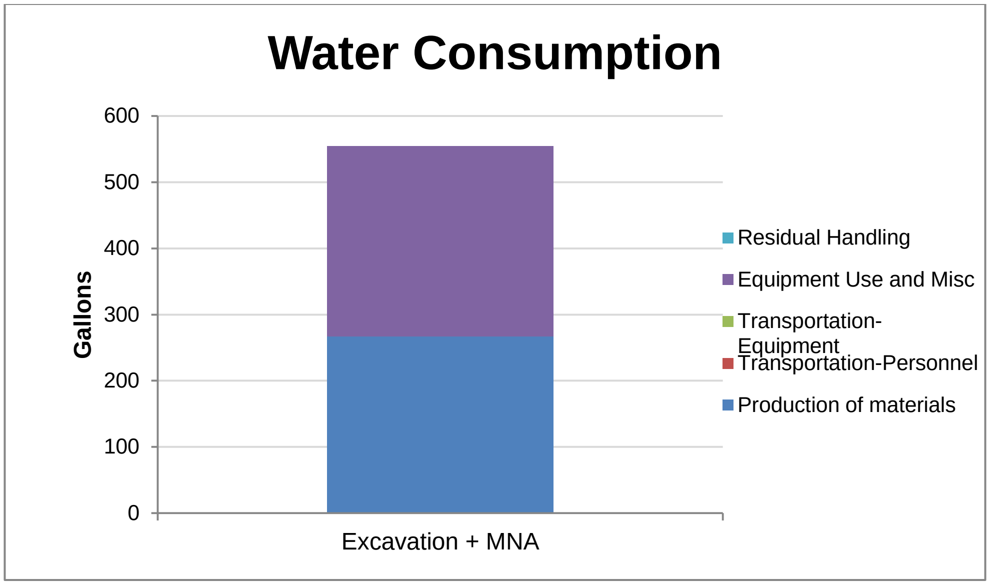


Figure 11 – Water Consumption for Monitoring Scenarios at UST Site 22 Pensacola

Figure 12 has a representation of the percentage breakdown of the contribution of the different sectors of the water use through the lifetime of the alternatives.

The total amount of water used by the Excavation and MNA Scenario is 553.9 gallons of water. The activity sector with the highest water use is the equipment use and miscellaneous, where 287.1 gallons of water were utilized during the lifetime of this scenario. The equipment use and miscellaneous sector consumes approximately 51.8 percent of the total water usage. The production of materials has the second highest water use, where 266.8 gallons of water are used for this purpose. The production of materials consumes approximately 48.2 percent of the total water usage for this scenario.

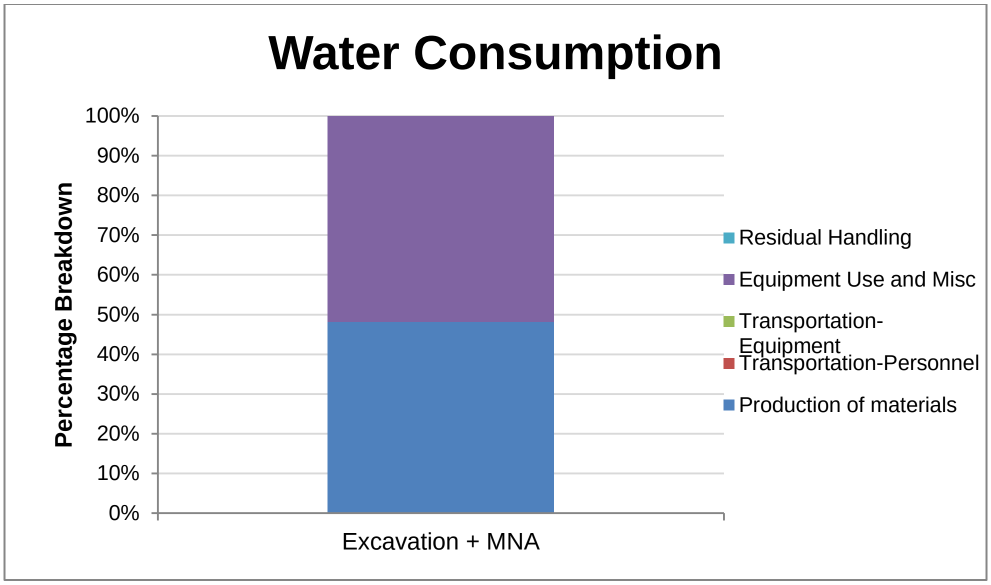


Figure 12 – Water Consumption Percentage Breakdown For Excavation and MNA Scenario at UST Site 22 Pensacola

Accident Risk

Accident Risk Fatality

Figure 13 shows the risk of fatality for the evaluated scenario. The x-axis represents the scenario evaluated, and the y-axis represents the risk of fatality.

For the Excavation and MNA scenario, the activity with the highest risk of fatality is the transportation of personnel followed by the equipment use and miscellaneous.

.

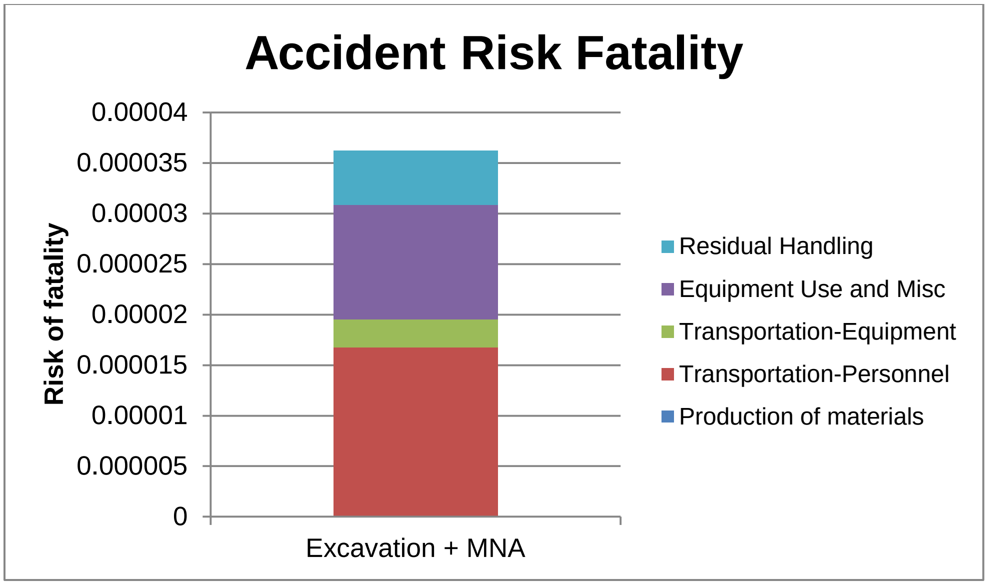


Figure 13 – Accident Risk Fatality For Monitoring Scenario At UST Site 22 Pensacola

Accident Risk Injury

Figure14 shows the risk of injury for the evaluated scenario. The x-axis represents the scenario evaluated, and the y-axis represents the risk of injury.

For all Alternatives, the activity with the highest risk of injury is the equipment use and miscellaneous, followed by transportation of personnel.

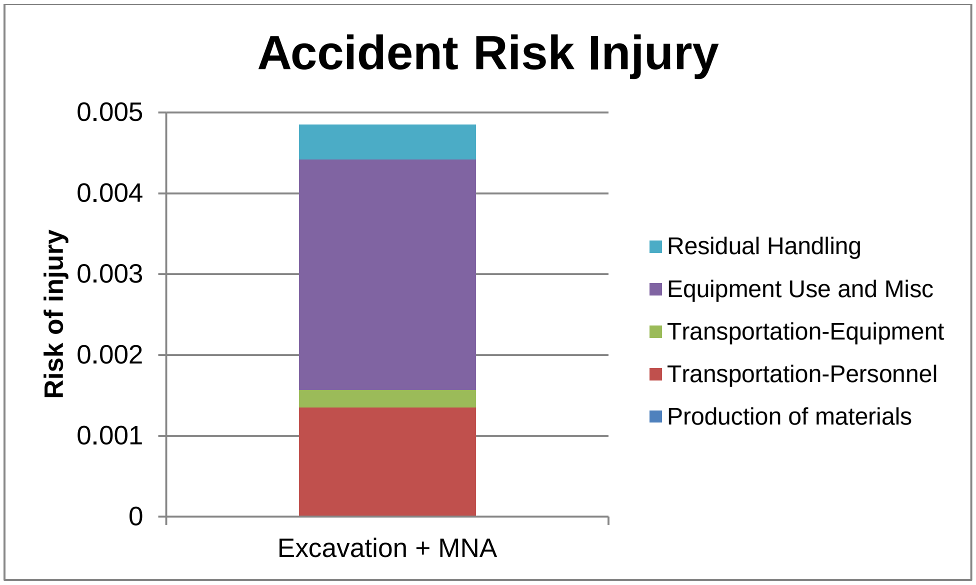


Figure 14 – Accident Risk Injury For Monitoring Scenarios At UST Site 22 Pensacola

Conclusions

During selection and design of the remedy, a sensitivity analysis considering elements of the remedy that have the greatest impact on remedy effectiveness, life-cycle cost, and environmental footprint metrics may provide additional insight into appropriate optimization. To aid in the sensitivity analysis, an impact analysis summary was created to qualitatively highlight the relative impact of respective metrics for the two alternatives and to identify the primary drivers of emissions, energy consumption, and water usage for each alternative (see Table 2 for details).

Figures 2, 4, 6, 8, 10 and 12 show the percentage breakdown of each of the sectors that take place during the remedial alternatives. In these graphs, it is easy to identify the sector whose contribution is largest from all other sectors to that impact category. An advantage to identifying where the large contributions are, the optimization process for lowering the environmental impacts is faster and could be more efficient.

Measures identified in the evaluation that may reduce the environmental footprint of the alternatives are listed below for consideration.

- Consider revising the amount of fill needed. The impacts generated from the production of soil from the borrow soil are high in regards of energy consumption.
- Consider a transportation program where it reduces the number of trips to and form site. Consider the implementation of technology that reduces environmental impacts.
- Optimize the number of samples analyzed during the LTM stage given that the laboratory analytical services is one of the major drivers in some of the impact categories.
- Some reduction of the environmental footprint, particularly GHG emissions and energy consumption, could be realized for all alternatives through the possible use of emission control measures such as alternate fuel sources (e.g. biodiesel), equipment exhaust controls (e.g. diesel), and equipment idle reduction.

However, before selecting and implementing a particular transportation option, further analysis should be performed with regards to the cost and feasibility of implementing different types of transportation vehicles and fuel sources. One factor to consider for alternative vehicle transportation is the cost of technology. Typically, technology that has been in place for a number of years tends to be cheaper (i.e. light trucks that use diesel) while emerging technologies (i.e. hybrid trucks that use gasoline or even electric trucks) tend to be more expensive and face more challenges as new technology and techniques are being established.

In general, continual optimization throughout the project life-cycle for UST 22 in accordance with Navy policy and guidance will continually reduce the life-cycle environmental footprint of the project as well as life-cycle costs.

<u>REFERENCES</u>

(a) NAVFAC, DON Guidance for Optimizing Remedy Evaluation, Selection, and Design, March 2010

(b) NAVFAC, DON Policy on SiteWise™ Optimization/GSR Tool Usage, email received from Brian Harrison/NAVFAC HQ dated 10 AUG 2010

Table C-1

Environmental Footprint Evaluation Results

Underground Storage Tank Site 22, Naval Air Station Pensacola

Pensacola, Florida

Alternative	Activities	GHG Emissions	Total Energy Used	Water Impacts	NO_X Emissions	SO_X Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
		metric ton CO_2e	MMBTU	gallons	metric ton	metric ton	metric ton		
Excavation + MNA	Materials Production	3.703	218.795	266.804	0.00E+00	3.66E-03	5.32E-04	NA	NA
	Transportation-Personnel	0.819	10.306	NA	3.03E-04	1.07E-05	6.15E-05	1.68E-05	1.35E-03
	Transportation-Equipment	1.107	14.442	NA	3.48E-04	6.15E-06	3.09E-05	2.74E-06	2.21E-04
	Equipment Use and Misc	14.027	210.744	287.170	6.10E-02	3.07E-02	3.51E-03	1.13E-05	2.85E-03
	Residual Handling	4.055	70.876	NA	1.30E-02	6.68E-03	3.56E-02	5.38E-06	4.33E-04
	Total	23.710	525.162	553.974	0.075	0.041	0.040	0.000	0.005

Table C-2
Environmental Impact Drivers
Environmental Footprint Evaluation Results
Underground Storage Tank Site 22, Naval Air Station Pensacola
Pensacola, Florida

Alternative	GHG Emissions	Total Energy Used	Water Impacts	NO_X Emissions	SO_X Emissions	PM_{10} Emissions	Accident Risk Fatality	Accident Risk Injury
Excavation + MNA	Laboratory Services	Production of borrow soil	Decontaminati on water	Laboratory Services	Laboratory Services	Residual Handling	Transportation of personnel	Equipment Use

APPENDIX C-2 INPUT INVENTORIES AND ASSUMPTIONS

Alternative: Excavation and Monitoring Natural Attenuation

RAC

Materials

Item	Quantity	Units	Comments
Decon water	275.00	gallons	5 drums, 55 gallons per drum
Temporary Equipment Decon Pad	700.47	lb	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	441.16	lb	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Compact Clean Fill Material	186,666.67	lb	140CY, 1.5 CY per ton, 2000 lb per ton, assume soil
Erosion control blanket	33.33	lb	Assume HDPE, 200 ft long, 3 lb per 18 ft long, 39 in wide,
Site Restoration Sand	50,004.80	lb	1000 sf, Assume 6 in thick, 1602 kg/m3

Transportation-Personnel

Item	Quantity	Units	Comments
Construction Survey (site preparation)	200.00	miles	25 miles per trip, 2 trips per day, 2 days, 2 people
Site Foreman (site preparation)	100.00	miles	25 miels per trip, 2 trips per day, 2 days, 1 person
Site Foreman (excavation)	300.00	miles	25 miles per trip, 2 trips per day, 6 days, 1 person

Transportation-equipment

Item	Quantity	Units	Comments
Pressure Washer (electric)	0.01	ton	1 pressure washer, 25 pounds, 100 miles round trip
Excavator, 2 cy	20.00	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Crawler mounted 2.0 cy hydraulic excavator (stand by)	20.00	ton	1 excavator, 20 ton per excavator, 100 miles round trip
Wheel loader, 3 CY	20.49	ton	1 front end loader, 20.4 tons
Wheel loader 3 CY (stand by)	20.49	ton	1 front end loader, 20.4 tons

Transportation-materials

Item	Quantity	Units	Comments
Temporary Equipment Decon Pad	0.35	ton	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3
Temporary Equipment Decon Pad	0.22	ton	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3
Compact Clean Fill Material	93.33	ton	140CY, 1.5 CY per ton, 2000 lb per ton, assume soil
Erosion control blanket	0.02	ton	Assume HDPE, 200 ft long, 3 lb per 18 ft long, 39 in wide,
Site Restoration Sand	25.00	ton	1000 sf, Assume 6 in thick, 1602 kg/m3

Equipment Use

Item	Quantity	Units	Comments
Pressure Washer (electric)	32.00	hours	5 days, 8 hours per day, 80% efficiency
Excavator, 2 cy	32.00	hours	5 days, 8 hours per day, 80% efficiency
Wheel loader, 3 CY	32.00	hours	5 days, 8 hours per day, 80% efficiency

Residual Handling

Item	Quantity	Units	Comments
Decon water disposal	1.14	ton	5 drums, 55 gallons per drum, 8.31 ppg, 2000 lb per ton
Disposal Non-hazardous soil	196.00	ton	

Transportation-residual handling

Item	Quantity	Units	Comments
Decon water disposal	100.00	miles	5 drums, 55 gallons per drum, 8.31 ppg, 2000 lb per ton
Disposal Non-hazardous soil	100.00	miles	

Laboratory Services

Item	Quantity	Units	Comments
Delineation Samples	2,000.00	dollars	10 samples, $200 per sample,
Confirmatory Samples	1,000.00	dollars	5 samples, $200 per sample,

LTM

Transportation-Personnel

Item	Quantity	Units	Comments
Senior Geologist (stage 1)	100.00	miles	25 miles per trip, 2 trips per day, 2 days, 1 person
Sampling personnel (stage 1)	500.00	miles	25 miles per trip, 2 trips per day, 5 days, 2 person
Sampling personnel (stage 2)	300.00	miles	25 miles per trip, 2 trips per day, 3 days, 2 person
Sampling personnel (stage 3)	300.00	miles	25 miles per trip, 2 trips per day, 3 days, 2 person
Senior Geologist (stage 4)	50.00	miles	25 miles per trip, 2 trips per day, 1 days, 1 person
Sampling personnel (stage 4)	300.00	miles	25 miles per trip, 2 trips per day, 3 days, 2 person

Laboratory Services

Item	Quantity	Units	Comments
Lab Analysis Stage 1	3,600.00	$	18 samples; assume lab cost of $200/sample
Lab Analysis Stage 2	3,600.00	$	18 samples; assume lab cost of $200/sample
Lab Analysis Stage 3	3,600.00	$	18 samples; assume lab cost of $200/sample
Lab Analysis Stage 4	3,600.00	$	18 samples; assume lab cost of $200/sample

Residual Handling

Item	Quantity	Units	Comments
IDW (baseline)	0.60	tonne	Baseline monitoring: 6 deep wells (45 feet), 12 shallow wells (15 ft), 6 inch diameter, 1 volume flush, density of sludge 721 kg/m3
IDW (quarterly (total)	1.80	tonne	Quarterly monitoring (3 total): 6 deep wells (45 feet), 12 shallow wells (15 ft), 6 inch diameter, 1 volume flush, density of sludge 721 kg/m4

Transportation-residual handling

Item	Quantity	Units	Comments
IDW (baseline)	100.00	miles	distance to dispose IDW
IDW (quarterly (total)	100.00	miles	distance to dispose IDW

APPENDIX C-3 SITEWISE RESULTS

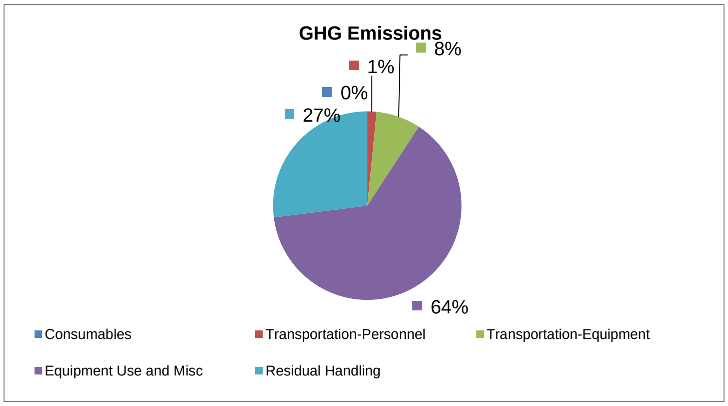
Sustainable Remediation - Environmental Footprint Summary
Excavation + MNA

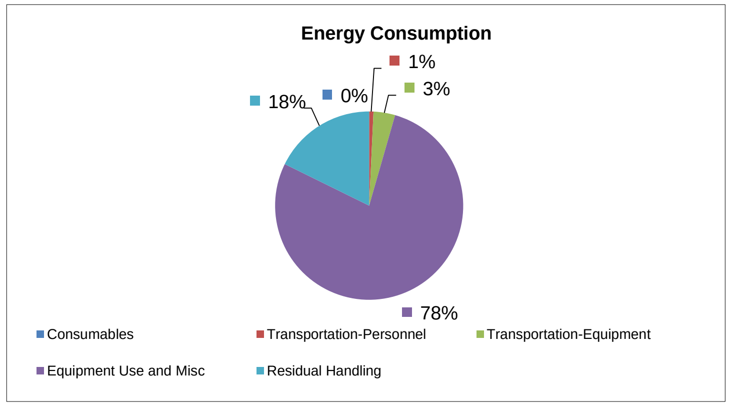
Phase	Activities	GHG Emissions (metric ton)	Total energy Used (MMBTU)	Water Consumption (gallons)	NOx emissions (metric ton)	SOx Emissions (metric ton)	PM10 Emissions (metric ton)	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.23	2.9E+00	NA	8.5E-05	3.0E-06	1.7E-05	4.7E-06	3.8E-04
	Transportation-Equipment	1.11	1.4E+01	NA	3.5E-04	6.2E-06	3.1E-05	2.7E-06	2.2E-04
	Equipment Use and Misc	9.24	3.0E+02	5.5E+02	3.2E-02	1.5E-02	3.3E-03	1.1E-05	2.9E-03
	Residual Handling	3.91	6.9E+01	NA	1.3E-02	6.7E-03	3.6E-02	4.6E-06	3.7E-04
	Sub-Total	14.48	3.89E+02	5.54E+02	4.50E-02	2.14E-02	3.90E-02	2.34E-05	3.82E-03
Remedial Action Operations	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.59	7.4E+00	NA	2.2E-04	7.7E-06	4.4E-05	1.2E-05	9.7E-04
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	8.49	1.3E+02	0.0E+00	2.9E-02	2.0E-02	7.4E-04	0.0E+00	0.0E+00
	Residual Handling	0.15	1.9E+00	NA	4.6E-05	8.1E-07	4.1E-06	7.8E-07	6.3E-05
	Sub-Total	9.23	1.36E+02	0.00E+00	2.97E-02	1.96E-02	7.93E-04	1.29E-05	1.04E-03
Total		**2.4E+01**	**5.3E+02**	**5.5E+02**	**7.5E-02**	**4.1E-02**	**4.0E-02**	**3.6E-05**	**4.9E-03**

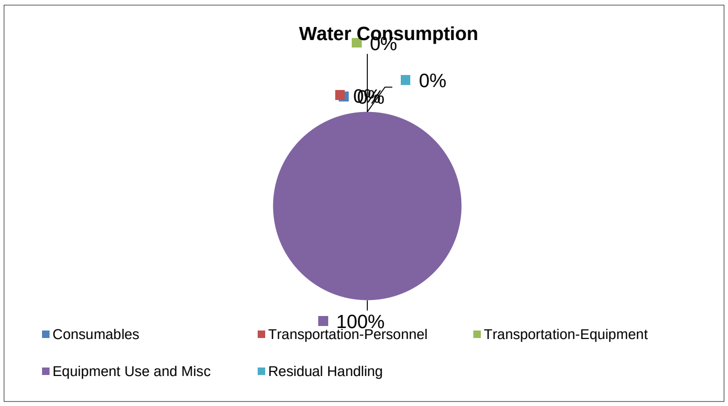
Remedial Alternative Phase	Non-Hazardous Waste Landfill Space (tons)	Hazardous Waste Landfill Space (tons)	Topsoil Consumption (cubic yards)	Costing ($)	Lost Hours - Injury
Remedial Investigation	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Remedial Action Construction	2.0E+02	0.0E+00	1.4E+02	0	3.1E-02
Remedial Action Operations	0.0E+00	0.0E+00	0.0E+00	0	0.0E+00
Longterm Monitoring	0.0E+00	0.0E+00	0.0E+00	0	8.3E-03
Total	**2.0E+02**	**0.0E+00**	**1.4E+02**	**$0**	**3.9E-02**

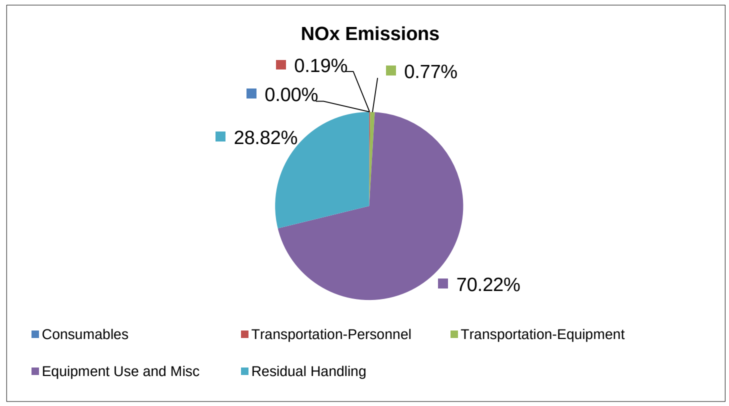
Total Cost with Footprint Reduction
$0

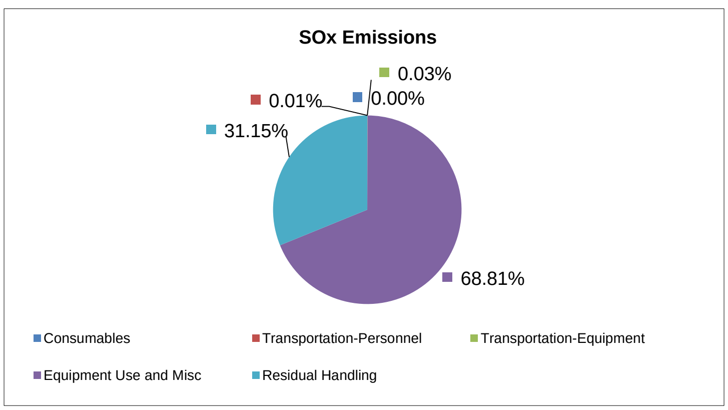
SiteWise™ Results Scenario 1: Excavation and MNA
Rmedial Action Construction Stage
Underground Storage Tank Site 22, Naval Air Station Pensacola
Pensacola, Florida

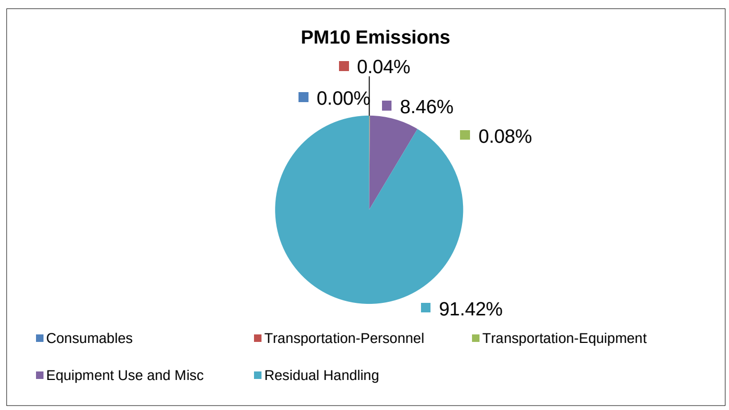


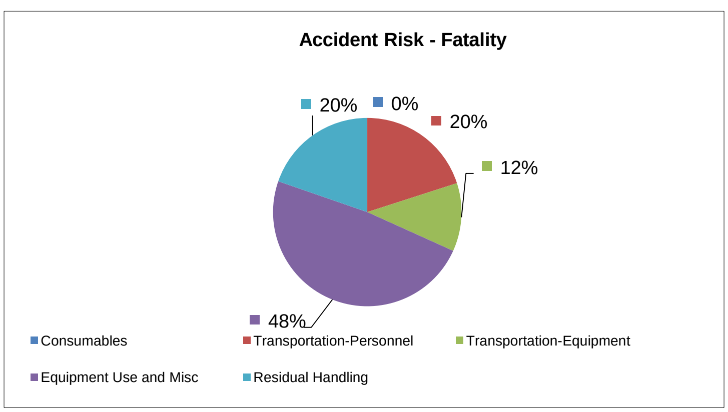


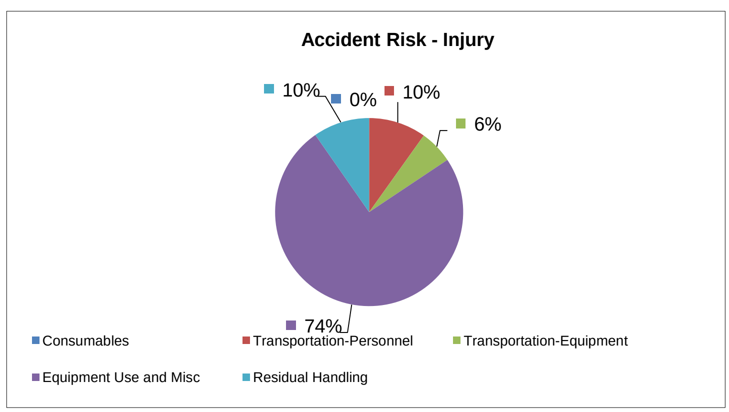




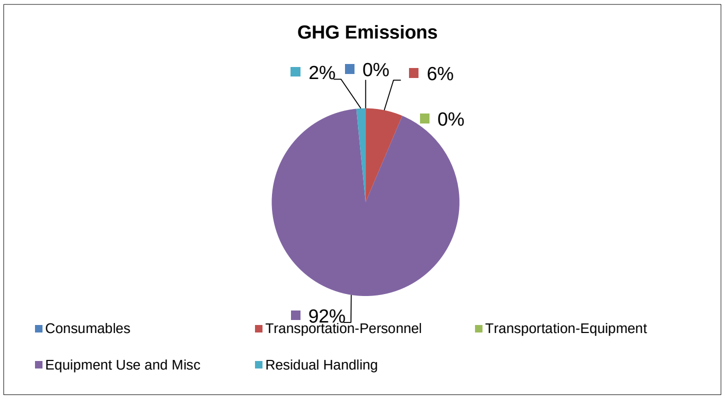


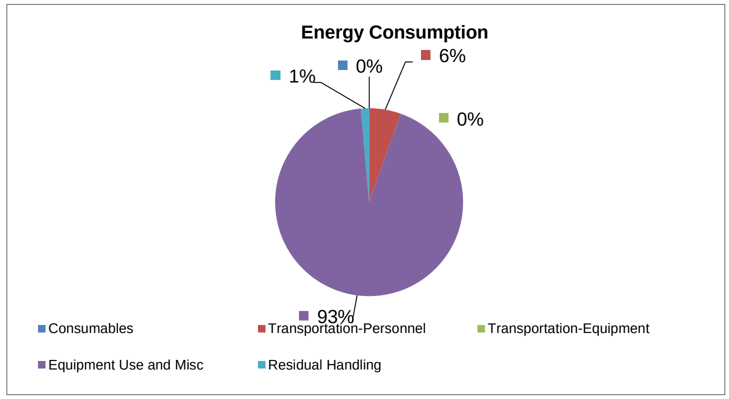


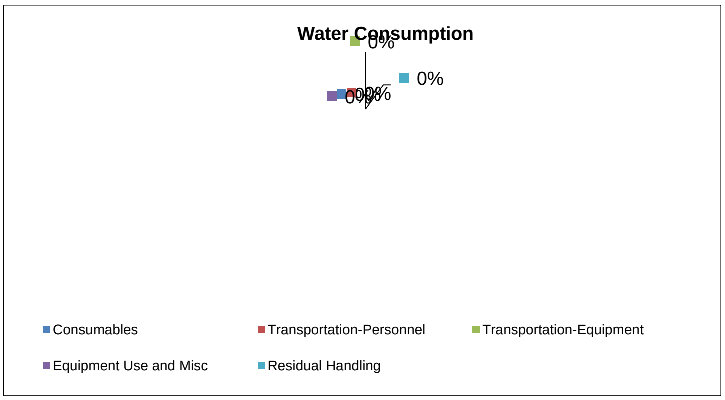


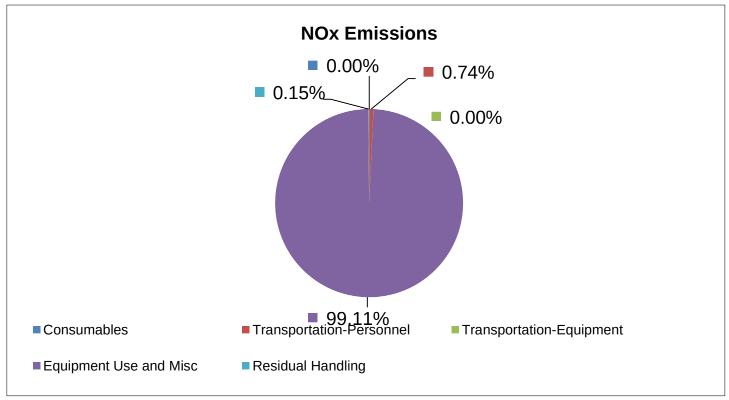


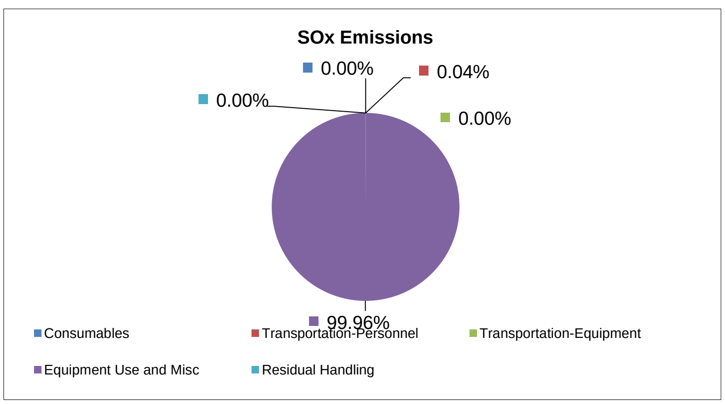
SiteWise™ Results Scenario 1: Excavation and MNA
Rmedial Action Construction Stage
Underground Storage Tank Site 22, Naval Air Station Pensacola
Pensacola, Florida

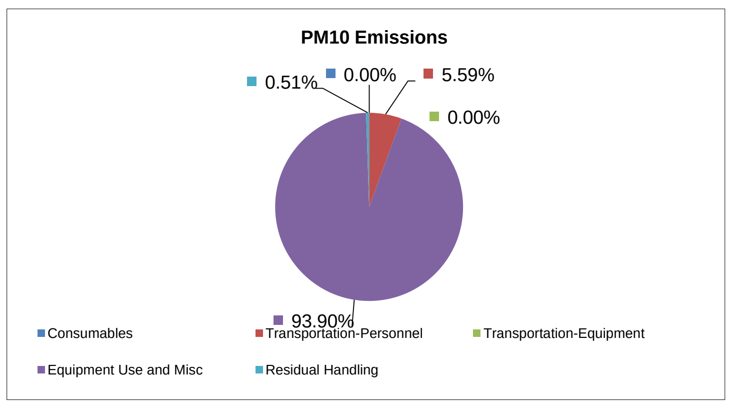


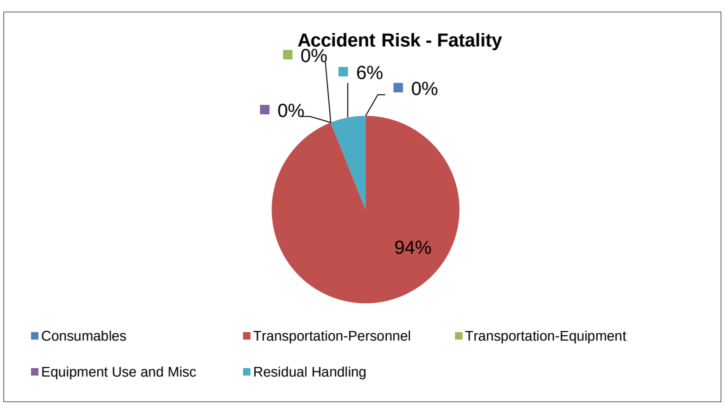


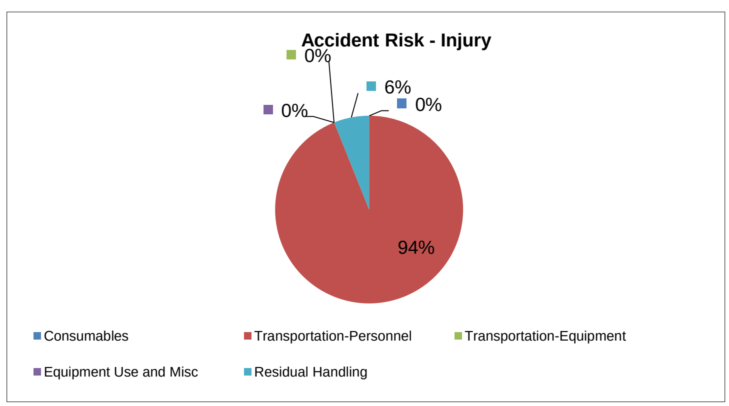




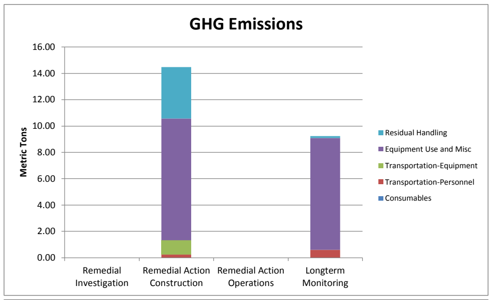


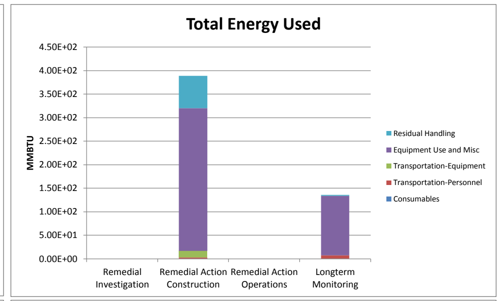


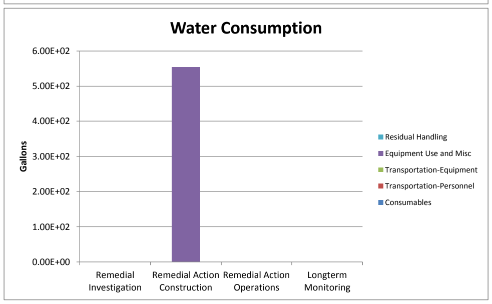


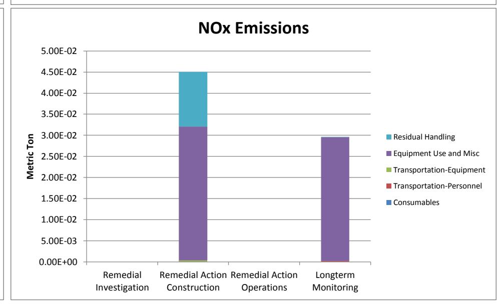


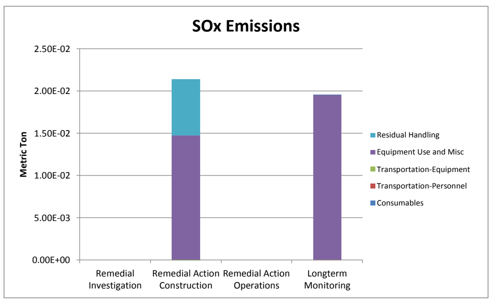
SiteWise™ Results Scenario 1: Excavation and MNA
Rmedial Action Construction Stage
Underground Storage Tank Site 22, Naval Air Station Pensacola
Pensacola, Florida

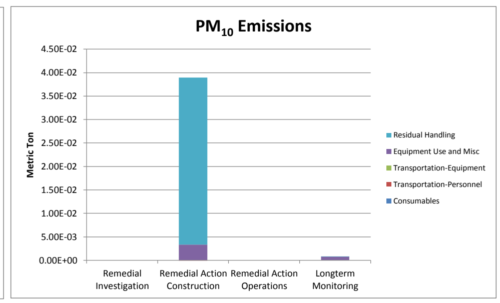


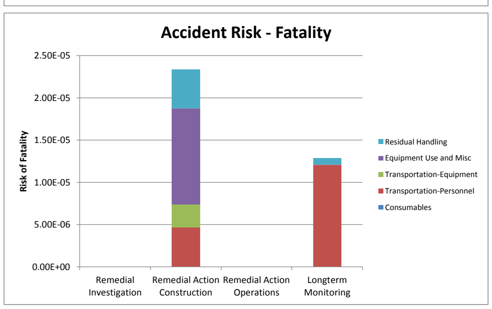


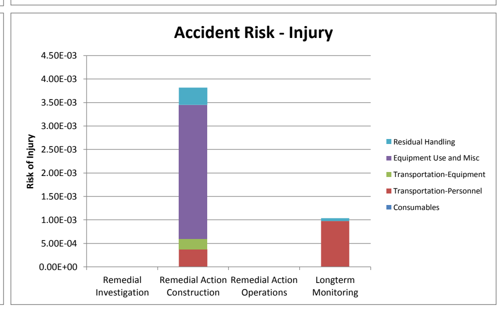


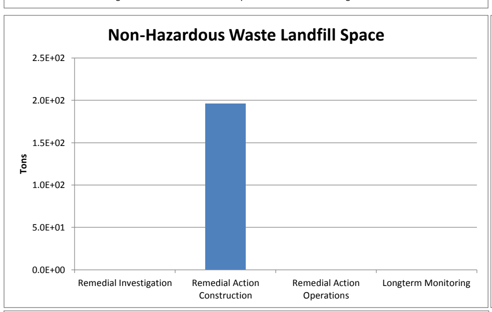


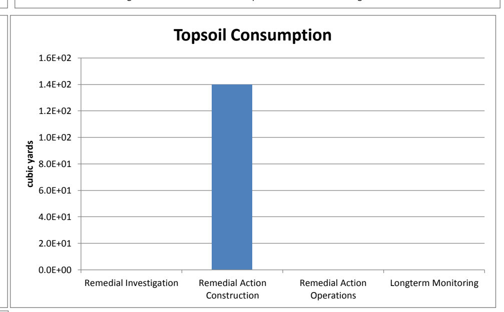


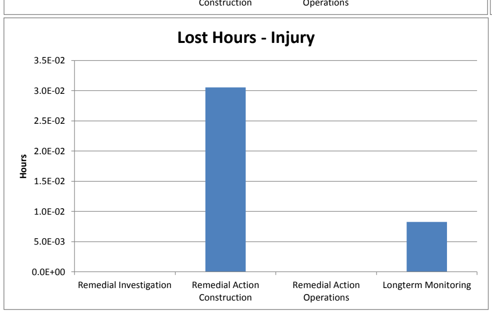












						Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	Technology Module / Phase	Module Components	Comments / Assumptions	Quantity	(Units)	$CO_{2\ equiv}$	CO_2	N_20	CH_4	NO_x	SO_x	PM_{10}		
Stage	**Materials**								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Temporary Equipment Decon Pad	HDPE	assume HDPE, Assume 30ftx40ft, 3 mm thick, 0.95 g/cm3	700.47	lbs	1.56	0.83	0.00	0.01	0.00	0.00	0.00	9.17	0.25
RAC	Temporary Equipment Decon Pad	Wood	Assume wood, 4x4 in, 120 ft of timber, density for pine 530 kg/m3	441.16	lbs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
RAC	Compact Clean Fill Material	Soil	140CY, 1.5 CY per ton, 2000 lb per ton, assume soil	186,666.67	lbs	1.95	1.95	0.00	0.00	0.00	0.00	0.00	51.45	0.00
RAC	Erosion control blanket	HDPE	Assume HDPE, 200 ft long, 3 lb per 18 ft long, 39 in wide,	33.33	lbs	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.44	0.01
RAC	Site Restoration Sand	Sand	1000 sf, Assume 6 in thick, 1602 kg/m3	50,004.80	lbs	0.11	0.11	0.00	0.00	0.00	0.00	0.00	3.06	0.00
	Subtotal					**3.70**	**2.93**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**64.13**	**0.27**
	Construction Equipment								**Tonnes**				**MWhr**	**gal x 1000**
RAC	Excavator, 2 cy	Excavator, Hydraulic, 2 CY (diesel)	5 days, 8 hours per day, 80% efficiency	32.00	hrs	3.10	3.10	0.00	0.00	0.02	0.01	0.00	14.08	
RAC	Wheel loader, 3 CY	Loader, 155 HP, 3 CY (diesel)	5 days, 8 hours per day, 80% efficiency	32.00	hrs	0.65	0.65	0.00	0.00	0.01	0.00	0.00	2.74	
	Subtotal					**3.75**	**3.75**	**0.00**	**0.00**	**0.03**	**0.01**	**0.00**	**16.82**	**0**
				Total		**7**	**7**	**0.00**	**0.01**	**0.03**	**0.01**	**0.00**	**81**	**0**

Alternative 1
Values Input into SiteWise as "Other"

Module	Greenhouse Gas Emissions				Criteria Pollutant Emission			Energy Consumption	Water Consumption
	$CO_{2\ equiv}$	CO_2	N_20 (CO2e)	CH_4 (CO2e)	NO_x	SO_x	PM_{10}		
				Tonnes				**MMBTU**	**gal**
RI	-	-	-	-	-	-	-	-	-
RAC	7.45	6.68	0.64	0.13	0.03	0.01	0.00	276.17	266.80
RAO	-	-	-	-	-	-	-	-	-
LTM	-	-	-	-	-	-	-	-	-

Note: 1 MWhr = 3412141.4799 BTU, 1MMTBU = 10^6 BTU

APPENDIX D

RAP SUMMARY SHEET AND CHECKLIST

DEP Form # 62-770.900(4)
Form Title: Remedial Action Plan Summary
Effective Date: September 23, 1997

Remedial Action Plan Summary

Site Name ______________________________
Location ______________________________
Media Contaminated: ☐ Groundwater ☐ Soil

FDEP Facility ID No. ______________
Current Date ___/___/___
Date of Last GW Analysis ___/___/___

Type(s) of Product(s) Discharged:
☐ Gasoline Analytical Group
☐ Kerosene Analytical Group (Diesel)
- Estimated Petroleum Mass (lbs):
  - Groundwater ________
  - Saturated Zone Soil ________
  - Vadose Zone Soil ________
- Area of Plume ________________ (ft^2)
- Thickness of Plume ______________ (ft)

Groundwater Recovery and Specifications:
- No. of Recovery Wells ______
  - ☐ Vertical ☐ Horizontal
- Design Flow Rate/Well __________ (gpm)
- Total Flow Rate ______________ (gpm)
- Hydraulic Conductivity _________ (ft/day)
- Recovery Well Screen Interval _______ (ft)
- Depth to Groundwater ____________ (ft)

Method of Groundwater Remediation:
☐ Pump-and-Treat
- ☐ Air Stripper
  - ☐ Low Profile ☐ Packed Tower
- ☐ Diffused Aerator
- ☐ Activated Carbon
  - ☐ Primary Treatment ☐ Polishing

☐ In Situ Air Sparging
- No. of Sparge Points ______
  - ☐ Vertical ☐ Horizontal
- Pressure ______________________ (psi)
- Design Air Flow Rate/Well ________ (cfm)
- Total Air Flow Rate _____________ (cfm)

☐ Biosparging
- No. of Sparge Points ______
  - ☐ Vertical ☐ Horizontal
- Design Air Flow Rate/Well ________ (cfm)

☐ Bioremediation
- ☐ In Situ ☐ Ex Situ

☐ Other ______________________________

Method of Groundwater Disposal:
☐ Infiltration Gallery ☐ Sanitary Sewer
☐ Surface Discharge/NPDES ☐ Injection Well
☐ Other ______________________________

Free Product Present: ☐ Yes ☐ No
- Estimated Volume ______________ (gal)
- Maximum Thickness _____________ (in)
- Method of Recovery (check all that apply):
  - ☐ Manual Bailing ☐ Skimming Pump
  - ☐ Other ____________________________

Method of Soil Remediation:
☐ Excavation
- Volume to be Excavated ___________ (yds^3)
- ☐ Thermal Treatment ☐ Land Farming On Site
- ☐ Landfill ☐ Bioremediation
- ☐ Other ____________________________

☐ Vapor Extraction System (VES)
- No. of Venting Wells ______
  - ☐ Vertical ☐ Horizontal
- VES - Applied Vacuum ______________ (wg)
- Design Air Flow Rate _______________ (cfm)
- Design Radius of Influence ____________ (ft)
- Air Emissions Treatment
  - ☐ Thermal Oxidizer ☐ Catalytic Converter
  - ☐ Carbon ☐ Other _________________

☐ Soil Bioventing
- No. of Venting Wells ______
  - ☐ Vertical ☐ Horizontal
- Design Air Flow Rate _______________ (cfm)

☐ In Situ Bioremediation
☐ Other ______________________________

Natural Attenuation:
- Method of Evaluation
  - ☐ Rule 62-770.690(1)(e), F.A.C.
  - ☐ Rule 62-770.690(1)(f), F.A.C.

Estimated Time of Cleanup: ___________ (days)
- Method of Estimation
  - ☐ Pore Volumes (no. of pore vols. = _______)
  - ☐ Exponential Decay (Decay Rate) ____ (day^{-1})
  - ☐ Groundwater Model
  - ☐ Other ____________________________

Estimated Cost:
- Est. Capital Cost (incl. install.) $ ___________
- Est. O & M Cost (per year) $ _____________
- Est. Total Cleanup Cost $ _______________

REMEDIAL ACTION PLAN & SYSTEM DESIGN CHECKLIST

Bureau of Petroleum Storage Systems
Florida Department of Environmental Protection

Facility Name: _____UST Site 22, NAS Pensacola____________________________________ Preapproval Site: [ ]

Location: _____Pensacola, Florida______________________________________ State Cleanup Site: [ ]

FAC ID No: ______NA____ Voluntary Cleanup Site: [X]

Reviewer: ____ Contractor: _____Tetra Tech, Inc. _______

This checklist should not be applied in blanket fashion. Technical judgment may be necessary in determining the applicability of some items. However, all information listed that is relevant to the remedial design should be provided.

I. GENERAL

_______ (1) RAP signed, sealed, and dated by Florida P.E. (per Section 471.025, FS)

_______ (2) indication whether proposed plan is for preapproval program, state contracted cleanup, or voluntary cleanup

_______ (3) recap of SAR information and conclusions pertinent to RAP preparation

_______ (4) current sampling results [within nine (9) months] used for remediation system design

_______ (5) potable water considerations:

- ♦ method of potable water supply to site and surrounding area
- ♦ locations of private wells within 1/4-mile, and public wells within 1/2-mile radius of site
- ♦ indication whether FDEP district office drinking water program was notified if contaminated groundwater could be expected to reach any public or private water well. Method of notification, person notified, and date

_______ (6) identification underground utilities locations, and those which may enhance transport of contaminants

_______ (7) • cleanup time: estimated cleanup time for the groundwater, for the soil

_______ (8) fencing of treatment area required, unless public access is restricted by institutional controls

_______ (9) local, state, and federal permits to be obtained, and conditions stated

_______ (10) recap of alternatives discussed and/or alternative selected during pre-RAP conference, or cost-effectiveness analysis of alternatives and identification of recommended alternative

_______ (11) statement that signed and sealed as-built (record) drawings will be provided

_______ (12) nuisance noise and odor to neighbors avoided by careful location of equipment items and exhaust stacks or other mitigating measures

II. REQUIREMENTS OF THE PRE-APPROVAL PROGRAM REMEDIAL ACTION INITIATIVE (RAI)

For cleanup projects affected by the Pre-Approval Program Remedial Action Initiative, the requirements of this section apply. The items listed below in this section are to be taken into account for each of the operations covered by the other sections of this checklist.

_______ (1) Cleanup Goals established. End of Active Remediation goal: 70% of natural attenuation default concentrations (NADC), or 90% reduction of each contaminant group, in each key well in the source area, whichever is more

FAC ID No:____

stringent, in the specified time frame (typically one to four years). Longer cleanup times to achieve end of active remedial action goal require special justification.

________ (2) Pilot testing of the proposed remediation strategy is generally required. Exceptions require special justification.

________ (3) Remediation equipment must meet the specifications contained in the Remedial Action Initiative including reasonable safety factors.

________ (4) System designs includes adequate source area treatment wells, e.g. a safety factor of 2, and consideration of using parallel or zoned systems.

________ (5) Ultimate cleanup target levels need to be indicated, either (CTLs) of Chapter 62-770 for unconditional NFA, or Alternative CTLs for conditional NFA. For conditional NFA, owner's acknowledgement of future institutional controls at cleanup completion should be documented

________ (6) End of Active Remediation to be followed by Natural Attenuation Monitoring. An evaluation of "time to switch" from active remedial action to Natural Attenuation Monitoring to reach ultimate cleanup target levels may be performed to allow for the continuation of active remedial action if justified.

________ (7) Milestones schedule <u>must</u> be included in RAP using the BPSS milestone model. The schedule must identify key wells, contaminants of concern, baseline contaminant concentrations, and time to reach the end of active remedial action. A linear concentration vs. time profile shall apply to <u>each</u> contaminant group in <u>each</u> key well.

________ (8) Applicability of "difficult sites" evaluation procedures established (mandatory if post-assessment cleanup cost will likely exceed $500,000 or cleanup time will exceed 4 years). Some elements of the "difficult sites" evaluation procedures may be applicable to sites with cleanups, which will not exceed $500,000, or a 4 year cleanup time. If applicability established, FDEP PE must complete difficult sites checklist attached to May 21, 2003 Difficult Sites memorandum.

________ (9) RAP must include a Construction Plan and a construction schedule.

________ (10) RAP must include a Startup Test Plan, and startup testing must be conducted in accordance with manufacturer's recommendations.

________ (11) RAP must include a Preventative and Routine Maintenance Plan and checklist, a Repair Response Plan and maintenance visit schedule. The repair response plan must address sytem monitoring, equipmant operation and replacement part availability and supply.

________ (12) RAP must indicate that equipment will be UL approved (or equivalent) and will have a warranty

________ (13) Hour meters, flow meters, pressure gauges, and vacuum gauges specified for all critical components, including individual wells if necessary for optimization of system efficiency

________ (14) Autodialer system specified (telemetry may be specified with justification)

________ (16) Equipment items must be protected (covered or housed in a trailer).

________ (17) Specifications, and an Operations Manual must be provided to FDEP/LP, and a copy must be kept at the site.

________ (18) RAP specifies that Startup, Quarterlyand Annual Reports will be provided, and must include the information detailed in the RAI.

III. <u>FREE PRODUCT REMOVAL</u>

________ (1) free product plume identification

FAC ID No:____

_______ (2) description/design details of free product recovery system including:
♦oil/water separator sizing calculations and detention time ♦ free product storage tank of adequate size

_______ (3) automated product pump shutdown for high level in product tank

_______ (4) safety considerations: ♦ static electricity ♦ electrical & instruments per National Electrical Code

_______ (5) proper disposal and safe handling of flammable free product recovered

IV. SOIL REMEDIATION - GENERAL

_______ (1) volume of contaminated soil

_______ (2) recap of Source Removal activities and soil volume already excavated, if any

_______ (3) indication that contaminated soil will be remediated, or provide rationale for 'no action'

(4) soil cleanup target levels identified, extent of soil contamination should be delineated by use of both OVA screening results and laboratory analysis results

(5) Use of Level I Risk Management Options for soil considered, if applicable, including SPLP, TRPH fractionation, and calculation of site specific SCTLs based on soil properties

_______ (6) proper handling & treatment of excavated, contaminated soil, or proper handling & disposal of hazardous soil (e.g., ignitable, corrosive, reactive, toxic, or petroleum refining waste)

V. LAND FARMING OF SOIL

_______ (1) adequate surface area available (______ sq ft) to spread soil 6 to 12 inches thick

_______ (2) location of land farming operation

_______ (3) land farming area is flat (less than 5% slope)

_______ (4) impermeable base provided. Type: ________________________

_______ (5) surface water runoff controls provided

_______ (6) groundwater monitoring plan proposed if land farm is outside of immediate contamination area

_______ (7) frequency of tilling provided

_______ (8) frequency and details of nutrient application or other enhancements provided (if proposed)

_______ (9) soil sampling frequency and sampling methods provided

_______ (10) potential for land farm causing nuisance conditions evaluated

(11) underlying soil and groundwater monitoring procedures provided and acceptable

_______ (12) land farming will be continued until the contaminants of concern meet soil cleanup target levels

_______ (13) cost-effectiveness

_______ (14) ultimate disposition of soil discussed

_______ (15) need to fence land farm area considered

VI. LANDFILLING OF SOIL

_______ (1) landfill lined and permitted by FDEP

_______ (2) name and location of landfill provided along with conditions of acceptance

_______ (3) cost-effectiveness

Disposal of soil to be selcted by RAC

FAC ID No:____________________

________ (4) For out-of-state landfill disposal, evidence provided that petroleum contaminated soil disposal in the landfill complies with the landfill regulations of the other state.

VII. SOIL THERMAL TREATMENT

NA (1) name and location of thermal treatment facility provided

________ (2) facility is permitted for thermal treatment of petroleum contaminated soil

________ (3) pretreatment soil sample analyses

________ (4) cost-effectiveness

VIII. COMMERCIAL BIOREMEDIATION OF SOIL

NA (1) name and location of bioremediation facility provided

________ (2) facility is permitted for bioremediation of petroleum contaminated soil

________ (3) pretreatment soil sample analyses

________ (4) cost-effectiveness

IX. IN SITU BIOVENTING OF SOIL

NA (1) soil cleanup criteria identification

________ (2) estimated mass of contaminants of concern in the vadose zone

________ (3) recap of information and data from pilot study that is pertinent full-scale system design

________ (4) layout

- ♦ well type — vertical or horizontal ♦ well construction details
- ♦ location of air injection and air extraction wells with respect to contaminated soil plume location and depth
- ♦ location and depth of soil gas monitoring probes with respect to contaminated soil plume and the air injection and extraction wells

________ (5) design and operating parameters, equipment sizing calculations, mechanical details

________ (6) instruments, controls, gauges, and valves

________ (7) monitoring plan: CO_2; pertinent bioremediation parameters; contaminants of concern

________ (8) air emissions

- ♦ demonstration that primary mechanism of remediation will be bioremediation and not volatilization. Air flow rates will be limited based on oxygen demand for bioremediation as demonstrated by pilot study results
- ♦ evaluation of methods for off-gas treatment if pilot test indicated that a significant amount of hydrocarbon volatilization will occur

X. SOIL VAPOR EXTRACTION

NA (1) prerequisites: ♦ relatively permeable soil ♦ depth to groundwater > 3 ft ♦ relatively volatile contaminants

________ (2) recap of information and data from pilot study that is pertinent to full-scale system design:

(3) full-scale design

FAC ID No:____________________

NA (a) layout and spacing of SVE wells (consideration given to radius of influence and overlapping of radii)

________ (b) vapor extraction well(s)

- ♦ no. of wells ♦ cfm each well ♦ total cfm ♦ well type (vertical or horizontal) ♦ well construction details

________ (c) pneumatic design

- ♦ operating vacuum @ wellhead(s) (inches of water)
- ♦ piping system friction losses
- ♦ pump motor (hp) based on system losses plus required vacuum at wellhead

________ (d) vacuum source type: regenerative blower; positive displacement vacuum pump; other

- ♦ design specifications: cfm @ inches of water; operating cfm @ inches of water
- ♦ mfr; model; motor hp; rpm; performance curves
- ♦ nonferrous materials of construction and/or assembly to minimize potential for sparking and friction
- ♦ explosion-proof motor

________ (e) moisture separator/condensation trap ("knock out pot") prior to inlet of vacuum pump

________ (f) surface sealing provided for vacuum extraction, or existing concrete or asphalt adequate

________ (g) safety

- ♦ system operation at approximately 25% of Lower Explosive Limit (LEL)
- ♦ bleed valve provided to control flammable vapor concentrations

________ (h) instrumentation, gauges, and appurtenances

________ (i) air emissions control (general)

- ♦ method of off-gas treatment to be provided during first month of system operation (provide details in Section X or XI for carbon adsorption or thermal oxidation of off-gas, or provide details of an alternative method)

________ (j) system monitoring

- ♦ sample and analyze air emissions for total petroleum hydrocarbons, weekly for first month, monthly for next two months, quarterly thereafter
- ♦ vacuum measurement locations (suggestion: use monitor wells at various radial distances from extraction wells)
- ♦ acknowledge that air emission controls must be provided for at least first 30 days, but may have to be continued longer until petroleum hydrocarbon emissions to the atmosphere are less than 13.7 lbs/day

XI. VAPOR-PHASE CARBON ADSORPTION (for control of air emissions)

NA (1) recap of information and data from pilot study that is pertinent to full-scale system design, if a pilot was conducted

________ (2) cost-effectiveness evaluation in comparison to other alternatives for control of air emissions

________ (3) mechanical details, sizing calculations, and operating parameters

________ (4) instrumentation, controls, gauges, sampling and valves

________ (5) safety

- ♦ operation of system below Lower Explosive Limit (LEL) for type of vapors being handled

FAC ID No:____________________

- observance of appropriate requirements in Series 500 articles of the National Electrical Code — equipment shall meet either Class I, Group D, Division 1 or Class I, Group D, Division 2 hazardous area requirements, whichever is applicable, when an equipment item is located in a hazardous area as defined by the code

XII. THERMAL/CATALYTIC OXIDATION (for control of air emissions)

NA (1) cost-effectiveness evaluation in comparison to other alternatives for control of air emissions

________ (2) mechanical details, equipment sizing calculations, and operating parameters

________ (3) instrumentation, controls, gauges, and valves. [schematic or mobile unit manufacturer's drawings indicating instrumentation, controls, gauges, and valves for all process streams (contaminant-laden influent, fuel gas, and combustion air)]

________ (4) safety considerations include, but are not limited to:

- bleed valve or dilution control valve to maintain influent flammable vapor concentration at 25% of the Lower Explosive Limit (LEL)
- air purge prior to re-ignition
- observance of appropriate requirements in Series 500 articles of the National Electrical Code — equipment shall meet either Class I, Group D, Division 1 or Class I, Group D, Division 2 hazardous area requirements, whichever is applicable, when located in a hazardous area as defined by the code
- use of thermal or catalytic oxidizers which meet appropriate fire codes for handling natural or propane gas and prevention of furnace explosions — National Fire Protection Association, Industrial Risk Insurer’s, Factory Mutual, etc. Some of the most important safety shutdowns for gas-fired burners occur upon: high gas pressure; low gas pressure; loss of combustion supply air; loss or failure to establish flame; loss of control system actuating energy; power failure

XIII. GROUNDWATER EXTRACTION

NA (1) feasibility of using existing on-site wells for groundwater extraction considered

________ (2) recovery well summary

- recovery well or trench location(s) and construction details included (diameter, screen length, grout, etc.)
- recovery well depth and screen length appropriate for depth of contamination

________ (3) predicted horizontal and vertical area of influence provided

________ (4) expected drawdown in recovery well or trench

________ (5) consideration of multiple well configuration to minimize drawdown

________ (6) groundwater pump performance requirements, sizing, and description

- hydraulic design considerations (friction losses and suction lift)
- pump performance curve or information provided (flow rate vs. pressure)
- pump manufacturer, model; hp, rpm

________ (7) automated well level controls provided for stopping/starting groundwater pump(s)

________ (8) totalizing flowmeter installed on influent line from each groundwater recovery pump

________ (9) check valve provided on pump discharge piping if not integral to pump

FAC ID No:______________________________

_______ (10) shutoff/throttling valve provided on pump discharge piping

XIV. GROUNDWATER TREATMENT SYSTEM - GENERAL

__NA__ (1) influent concentrations for each contaminant of concern, for design of treatment system, based on either actual dynamic pump test sample, weighted averaging procedure, or other reasonable assumption

_______ (2) feasibility & cost-effectiveness of direct discharge of recovered contaminated groundwater to sewer treatment plant, instead of onsite treatment

_______ (3) site piping summary

- ♦ schematics of all treatment components, piping, valves, controls and appurtenances provided
- ♦ influent and effluent sampling ports provided
- ♦ piping type and size provided

_______ (4) fouling & scaling considerations

- ♦ whether control of iron fouling is necessary, either by filtration of influent to remove particulately-bound iron, and/or by removal or sequestering of dissolved iron to prevent precipitation in process equipment items
- ♦ whether pretreatment or other measures necessary to prevent precipitation of calcium carbonate (Langelier Index)
- ♦ whether pretreatment or scheduled O&M measures will be needed for control of biofouling

XV. AIR STRIPPING TREATMENT PROCESS

__NA__ (1) packed tower

- ♦ type, size, and surface area of packing
- ♦ design and operating parameters, sizing calculations, mechanical details (tower height; packing type, height, surface area; air/water ratio; pressure drop; blower type, model, hp; mist eliminator; etc.)

_______ (2) diffused aerator (tank type)

- ♦ design and operating parameters, sizing calculations, mechanical details (tank volume; contact time; air flow rate; pressure drop; removal efficiency of contaminants of concern; blower type, model, hp; etc.)

_______ (3) low profile air stripper

- ♦ design and operating parameters, sizing calculations, mechanical details (number of trays; water flow rate; air flow rate; air/water ratio; pressure drop; blower type, model, hp; mist eliminator)

_______ (4) general

- ♦ instrumentation, controls, gauges and valves
- ♦ air emissions calculations; emissions stack height
- ♦ equipment description if emissions treatment necessary
- ♦ automated recovery well shutdown when blower failure occurs
- ♦ sampling of effluent, daily for first three days, monthly for next two months, quarterly thereafter

XVI. LIQUID-PHASE CARBON ADSORPTION

__NA__ (1) recap of information and data from pilot study that is pertinent to full-scale system design, if a pilot was conducted

_______ (2) indication whether adsorption is for primary treatment of groundwater or polishing of effluent

FAC ID No:____

NA (3) carbon specifications

________ (4) carbon unit(s) sizing calculations (carbon usage rate, contact time, pressure losses) design assumptions

________ (5) TOC in groundwater determined and effect on carbon usage considered

________ (6) need for sand filter or cartridge unit prior to carbon unit considered

________ (7) pressure gauge and pressure relief valve provided on carbon (and sand) filter

________ (8) carbon disposal and replacement method

________ (9) series configuration of carbon units considered to allow for maximum carbon utilization and prevention of contaminant breakthrough to system effluent

________ (10) automated recovery well shutdown if primary carbon unit pressure too high

________ (11) schedule for sampling between and after carbon adsorption units

XVII. IN SITU AIR SPARGING OF GROUNDWATER

NA (1) prerequisites

- ♦ no or little free product which could spread via sparge turbulence, or prolong sparging
- ♦ volatile (C_3-C_{10}) petroleum fractions with Henry's Constant ≥ 0.00001 atm$*$m^3/mol (approx. rule of thumb, unless biosparging is proposed)
- ♦ no high concentrations of metals (iron, magnesium) to form oxides which plug aquifer or well screens, or high concentrations of dissolved calcium, which could react with CO_2 in air to clog aquifer w/calcium carbonate

________ (2) recap of information and data from pilot study that is pertinent to full-scale system design

(3) full-scale design

________ (a) groundwater contamination plume coverage

- ♦ location(s) and radius of influence for full-scale air injection well(s)
- ♦ adequate coverage by overlapping radii of influence if multiple well system

________ (b) air injection well(s): no. of wells; well design; operating air pressure at wellheads; cfm each well; total cfm ____________________

________ (c) avoidance of long screen allowing air to diffuse at top portion only, where air flow resistance is least (typ screen is 1 to 3 ft long)

________ (d) well depth and screened interval (or depth of sparge tip) appropriate w/respect to depth of contamination

________ (e) vapor extraction well(s) in conjunction w/sparging situated properly to recover volatiles and prevent their release to atmosphere

- ♦ injection cfm of air typically 20 to 80% of vapor extraction cfm (0.2 to 0.8)
- ♦ automatic shutdown of air injection upon loss of, or low, vapor extraction system vacuum, or failure of vacuum pump motor, in order to prevent air emissions
- ♦ adequate and cost-effective treatment of vapor extraction system off-gas proposed to prevent air emissions

________ (f) compressor

- ♦ design: cfm @ psig; operating cfm @ psig

FAC ID No:____

- ♦ type; mfr; model; motor hp; rpm; performance curves; air filter at compressor inlet; oil trap or oil-free compressor to avoid introducing more contamination to aquifer

________ (g) safety: pressure relief valve at discharge of compressor and/or high pressure switch for automatic shutdown

________ (h) instrumentation and gauges: pressure indicating gauges at each sparging well

________ (i) air flow control: shutoff/throttling valve at each well; other flow control device or method

XVIII. IN SITU BIOREMEDIATION

__NA__ (1) general:

- ♦ media to be remediated: groundwater; soil
- ♦ application method: direct-injection; recirculating/re-injection type system; addition to excavation pit
- ♦ aerobic or anaerobic
- ♦ stimulation of indigenous microorganisms or addition of microorganisms

________ (2) recap of information and data from pilot study that is pertinent to full-scale system design

________ (3) design and operating parameters (e.g.: injection well construction details; layout and spacing of wells commensurate with injection radius of influence for adequate horizontal coverage; screened interval of injection wells commensurate with vertical extent of contamination for adequate vertical coverage; injection pump develops adequate pressure and flow rate for injection , for the site-specific conditions.)

________ (4) dosage (of nutrients and/or microorganisms, per pound of hydrocarbon contaminants to be biodegraded) (Some bioremediation products may express dosage as a required amount per cubic yard of contaminated media.)

________ (5) RAP (or RAP Mod) must contain the necessary underground injection control information required by Chapter 62-528 FAC. [That is, the RAP must contain enough information for a state or local program reviewer to fill out the 2-page UIC notification memorandum titled "Proposed Injection Well(s) for In Situ Aquifer Remediation at a Petroleum Remedial Action Site".] This includes the following information:

- ♦ chemical analysis (composition) of the fluid to be injected. Note: The injected fluid must meet primary and secondary drinking water standards of Chapter 62-550, FAC, and the minimum groundwater criteria of Chapters 62-520 and 62-777 FAC, otherwise Rule 62-522.300(2)(c) may apply and/or a zone of discharge variance may be necessary.
- ♦ no. of injection wells ♦ no. of injection events ♦ injection volume per well per injection event
- ♦ total injection volume (i.e. the total for all injection wells, all injection events)

________ (7) anticipated schedule of injection events for nutrients and/or microorganisms (i.e. the timing and frequency of injections over the life of the project)

________ (7) provide additional oxygen, if necessary, if the bioremediation is aerobic and site's groundwater is lacking in dissolved oxygen. (method by which additional oxygen will be delivered.; provide design details if method of delivery is mechanical, e.g. air sparge, O_2 injection, iSOC, etc.; provide chemical information if oxygen is supplied chemically: e.g. magnesium peroxide, calcium peroxide, hydrogen peroxide, etc.)

________ (9) ♦ sampling plan includes not just the analysis of samples for petroleum contaminants of concern at a site, but also analyses necessary for any of the following that apply: compliance with the underground injection control

FAC ID No:______________________________________

regulations of Chapter 62-528; compliance with Rule 62-522.300(2)(c); and compliance with the terms of an injection zone of discharge variance. Also, analysis for more than just the reagents may be necessary, depending on the situation. In some cases, if there are environmental or toxicological concerns, it may be necessary to include analysis for intermediate degradation products of the reagents, or intermediate by-products formed by the interaction of those reagents with the petroleum contaminants of concern at a site.

- ♦ other samples and operating parameter measurements for a bioremediation project may inlcude, but are not necessarily limited to the following: pH, DO, ORP, N, P, Temperature, TOC, Alkalinity., microbe counts

XIX. LEAD (this section can also be adapted to other heavy metals if necessary)

__NA__ (1) discussion of area(s) where groundwater lead concentration exceeds 15 ppb

________ (2) lead concentrations (ppb): unfiltered (____); filtered (____); background (____)

________ (3) proposal for lead removal by filtration if unfiltered sample is greater than 15 ppb and filtered sample is less than 15 ppb

________ (4) method of lead removal, including pertinent design calculations

________ (5) if lead (or other heavy metals) will not be removed by filtration, then provide details of proposed treatment

XX. INFILTRATION GALLERY

__NA__ (1) recap of field percolation test results (preferably with double-ring infiltrometer)

________ (2) infiltration gallery construction details and location (upgradient location if site layout allows)

________ (3) gallery calculations/assumptions with mounding analysis

________ (4) piezometer and cleanout pipe in gallery

________ (5) geotextile filter fabric to be installed around and above gallery

________ (6) discussion or modeling of gallery for effect on plume migration

XXI. INJECTION WELL (for effluent disposal)

__NA__ (1) discussion of injection zone and relevant lithology information

________ (2) recap of information and data from pilot study that is pertinent to full-scale system design, if a pilot was conducted

________ (3) injection well location and construction details

________ (4) screened interval appropriate

________ (5) effluent discharge pump adequately sized for required injection flow rate and pressure

________ (6) carbon polishing unit (or equivalent)

________ (6) air release valve at highest point of effluent discharge piping

________ (7) injection rate (well hydraulics) calculations

________ (8) Underground Injection Control (UIC) inventory information provided. (RAP or RAP Mod must contain enough information for a technical reviewer to complete the 2-page UIC effluent injection notification.)

________ (9) evaluation of injection well's effect on potable wells and plume migration

FAC ID No:________________________________

XXII. ALTERNATIVE EFFLUENT DISPOSAL METHODS

__NA__ (1) cost-effectiveness comparison of alternatives (including general permit fee of $2,500 per year in the cost estimate for NPDES disposal, if it is one of the alternatives being compared)

________ (2) for surface water discharge

- ♦ conditions for NPDES general permit met
- ♦ indication that notice of intent for NPDES permit will be submitted after RAP approval

________ (3) if applicable, consumptive use permit obtained from Water Management District

________ (4) approval from municipality for sewer discharge, and conditions and effluent standards to be met

________ (5) applicable permits for stormwater discharge

XXIII. SAMPLING REQUIREMENTS

________ (1) designated / key monitoring wells and frequency of their sampling per 62-770.700, FAC

________ (2) analysis of designated / key monitoring well samples for appropriate contaminants of concern for the site

__NA__ (3) sampling of influent from recovery well(s); daily first 3 days, monthly next 2 months, quarterly thereafter

__NA__ (4) sampling of system effluent, daily for first three days, monthly for next two months, quarterly thereafter

________ (5) water level data collected at same time & frequency of monitoring well and recovery well sampling

XXIV. IN SITU CHEMICAL OXIDATION

__NA__ (1) media to be remediated: groundwater; soil

________ (2) recap of information and data from pilot study that is pertinent to full-scale system design

________ (3) design and operating parameters (e.g.: injection well construction details; layout and spacing of wells commensurate with injection radius of influence for adequate horizontal coverage; screened interval of injection wells commensurate with vertical extent of contamination for adequate vertical coverage; flow rates; temperatures; pressures; pH; concentrations, etc.)

________ (4) amount of reagents required per pound of hydrocarbons to be destroyed (theoretical amount, actual amount)

________ (5) RAP (or RAP Mod) must contain the necessary underground injection control information required by Chapter 62-528 FAC. [That is, the RAP must contain enough information for a state or local program reviewer to fill out the 2-page UIC notification memorandum titled "Proposed Injection Well(s) for In Situ Aquifer Remediation at a Petroleum Remedial Action Site".] This includes the following information:

- ♦ chemical analysis (composition) of the fluid to be injected. Note: The injected fluid must meet primary and secondary drinking water standards of Chapter 62-550, FAC, and the minimum groundwater criteria of Chapters 62-520 and 62-777 FAC, otherwise Rule 62-522.300(2)(c) may apply and/or a zone of discharge variance may be necessary.
- ♦ no. of injection wells ♦ no. of injection events ♦ injection volume per well per injection event
- ♦ total injection volume (i.e. the total for all injection wells, all injection events)

________ (6) ♦ sampling plan includes not just the analysis of samples for petroleum contaminants of concern at a site, but also analyses necessary for any of the following that apply: compliance with the underground injection control

FAC ID No:____

regulations of Chapter 62-528; compliance with Rule 62-522.300(2)(c); and compliance with the terms of an injection zone of discharge variance. Also, analysis for more than just the reagents may be necessary, depending on the situation. In some cases, if there are environmental or toxicological concerns, it may be necessary to include analysis for intermediate degradation products of the reagents, or intermediate by-products formed by the interaction of those reagents with the petroleum contaminants of concern at a site.

♦ other samples and operating parameter measurements for a chemical oxidation project may inlcude, but are not necessarily limited to the following: pH, DO, ORP, Temperature, and Alkalinity.

________ (7) anticipated schedule of injection events for reagents (i.e. the timing and frequency of injections over the life of the project)

________ (8) safety (items applicable to fire, explosion, toxicological and safe handling of chemicals may include, but are not necessarily limited to those listed below)

♦ material safety data sheets, toxicity, or other information pertinent to the chemicals and catalysts involved

♦ safe handling of chemicals: avoidance of mixing, premature mixing, or improper storage of incompatible chemicals

♦ Lower Explosive Level (LEL) considerations

♦ potential for vapor migration, either passively or by convection, or driven by air or other gases used, or generated by the heat of exothermic chemical reactions or the vaporization of free product by such heat

♦ the minimum tolerable distance between underground storage tanks and product piping and any in situ heat-generating process

♦ the need replace the flammable contents of petroleum storage tanks and their associated piping with non-flammable inerts such as nitrogen or carbon dioxide, in order to reduce risk of fire and explosion.

♦ observance of National Electrical Code (typically Series 500 articles for Class I, Group D, Division 1 or 2 hazardous area requirements) (for electrical equipment items located in a hazardous area)

♦ appropriate chemical-resistant and/or spark-resistant materials of construction for equipment items

♦ personal protection of workers

♦ safety considerations regarding neighbors and passersby